180534

# FIVE-YEAR REVIEW REPORT

**Second Five-Year Review Report**
**for**

## BOFORS-NOBEL SUPERFUND SITE

**EGELSTON TOWNSHIP, MUSKEGON COUNTY,**
**MUSKEGON, MICHIGAN**

**August, 2003**

**Pursuant to CERCLA**
**42 U.S.C., Section 9621**

**Prepared by:**
**United States Environmental Protection Agency**
**Region 5**
**Chicago, Illinois**

Wm. E. Muno

William E. Muno, Director
Superfund Division, Region 5

8/7/03
Date

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## EXECUTIVE SUMMARY AND FIVE YEAR REVIEW SUMMARY FORM

All current threats at the Bofors-Nobel site have been addressed through: controlled site access, continued extraction of contaminated groundwater before impacting Big Black Creek, and treatment of that contaminated groundwater in a groundwater treatment facility. The O.U. #1 Groundwater Treatment Plant (GWTP) achieved operational and functional status on May 19, 1998. Portions of the Remedial Design for the revised O.U. #1 Total In-Situ Containment (TIC) remedy are expected to be approved by 2004 to allow the start of some construction in that year, with completion of construction of all components of the TIC remedy planned for 2005.

The O.U. #1 remedy for the Bofors-Nobel Superfund site in Muskegon, Michigan is expected to be protective of human health and the environment by removing the threat from direct contact with sludge and contaminated soil through elimination of exposure using a clean-soil cover; by addressing the threat to Big Black Creek through controlling contaminated groundwater using an underground barrier wall, supplemented, if required, by extraction wells, and; by attainment of groundwater cleanup goals by utilizing treatment wetlands to treat contained groundwater. Groundwater restoration is expected to require approximately 40 to 70 years to achieve. In the interim, groundwater exposure pathways that could result in unacceptable risks are controlled by groundwater pumping with treatment in a constructed facility, to be replaced by the underground barrier wall, phytoremediation, and wetlands elements. Institutional control in the form of deed restrictions prohibiting future residential land use will be implemented during the groundwater containment and treatment time period by the Potentially Responsible Parties (PRPs, also known as the Performing Settling Defendants (PSDs)). It is expected that construction of the first phase of the O.U. #1 TIC remedy (the barrier wall) will be completed by December 2004 with additional phases being completed in 2005. Because the O.U. #1 remedy is being designed to also handle groundwater contamination migrating from the O.U.#2 area, a Record of Decision for O.U. #2 will be issued after the containment effectiveness of components of the TIC remedy has been determined. An interim remedy established by an Interim Remedial Action Plan (IRAP) for O.U. #2 consistent with the O.U. #1 design has been implemented and is protective of human health and the environment.

The triggering action for this five-year review is the first Five-Year Review Report of September 30, 1998. The assessment of this second five-year review found that the completed GWTP phase of the O.U. #1 remedy has been constructed in accordance with the requirements of the Record of Decision, and that operation and maintenance of the GWTP and extraction wells is controlling groundwater that discharges to Big Black Creek. Two amendments to the O.U. #1 Record of Decision were issued in 1992 and 1999 to reflect: new information regarding containment technology, reasonably anticipated future land use of the site, incorporation of revised State of Michigan cleanup criteria, and cost effectiveness.

| SITE IDENTIFICATION | | |
|---|---|---|
| **Site name:** BOFORS-NOBEL | | |
| **EPA ID:** MID006030373 | | |
| **Region: 5** | **State: MI** | **City/County:** MUSKEGON / MUSKEGON COUNTY |

| SITE STATUS | |
|---|---|
| **NPL status:** **X** Final ☐ Deleted ☐ Other (specify) | |
| **Remediation status** (choose all that apply): **X** Under Construction **X** Operating ☐ Complete | |
| **Multiple OUs?*** **X** YES ☐ NO | **Construction completion date: PLANNED:** 12 / 30 / 2005 |
| **Has site been put into reuse?** ☐ YES **X** NO | |

| REVIEW STATUS | |
|---|---|
| **Lead agency:** **X** EPA ☐ State ☐ Tribe ☐ Other Federal Agency | |
| **Author name: JOHN V. FAGIOLO** | |
| **Author title: REMEDIAL PROJECT MGR.** | **Author affiliation:** U.S. EPA SUPERFUND |
| **Review period:**** _03_ / _01_ / _2003___ to _06_ / 30 / _2003_ | |
| **Date(s) of site inspection:** _05_ / _22_ / _2003_ (SITE VISIT) | |

Issues: No immediate problems identified with the current status of the site and site remedy. Fouling of groundwater extraction wells may have influenced the effectiveness of groundwater control. Extraction wells are still capable of providing control. On-site personnel and access control measures prohibit unacceptable exposure to site contamination. As part of the TIC remedy design, information will be provided to confirm containment effectiveness. Revisions to ARARs for this site occurred in 1999 (ROD Amendment). Contaminant concentrations have been decreasing. Annual costs for the site remedy are less than originally estimated in 1992. Site responsibility has been transferred from U.S. EPA and MDEQ to the PRPs. Detailed negotiations in the remedy and in the transfer of treatment plant operations to the PRPs has caused some delay in remedy implementation, but has alleviated annual costs for U.S. EPA and MDEQ. The amended remedy from new information will be more cost effective and will provide a more natural containment and treatment method. Improperly functioning treatment process equipment caused some delay in treatment plant operational and functional declaration. An Interim Remedial Action Plan for O.U. #2 consistent with the O.U. #1 remedy has been implemented. A final ROD for O.U. #2 should not be developed until O.U. #1 remedy effectiveness can be determined. Remaining tasks at the site are: confirmation / improvement of extraction well pumping, O.U. #1 remedy design completion, O.U. #1 remedy construction and start-up, measurement of O.U. #1 remedy effectiveness, development and approval of O.U. #2 ROD, short- and long-term monitoring of all site remedies, operation and maintenance of all site remedies, and certification of achievement of site remedy cleanup goals (for eventual deletion of the site from the NPL).

Recommendations and Follow-up Actions: **Confirm pumping efficiencies of extraction wells and clean / maintain extraction wells to ensure groundwater control, implement deed restrictions as part of the O.U. #1 RA scope defined in the 1999 Consent Decree, as agreed to by site PRPs. Continue operation and maintenance for the site (by PRPs). Complete the O.U. #1 RD using a phased approach. Portions of the TIC remedy can be designed and construction started in 2004, while other portions of the RD can be approved later in 2004. Completion of construction of the O.U. #1 remedy is targeted for 2005, with the vegetative portions of the remedy maturing by approximately 2008 to 2010. Implement detailed monitoring of soil, groundwater, and surface water to establish remedy effectiveness and continued protection of human health and the environment. The O.U. #2 ROD is targeted for development and completion later in 2004. U.S. EPA and MDEQ will continue to monitor the site's progress and approve each phase of the site remedy. An approximate schedule for implementation of these recommendations is shown in Table 12.**

Protectiveness Statement(s): The completed portion of the O.U. #1 remedy is protective of human health and the environment by controlling contaminated groundwater. The portion of the amended O.U. #1 remedy currently being designed is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals, through containment technology enhanced with phytoremediation. Control of contaminated groundwater will continue at the site for as long as necessary until groundwater cleanup goals are achieved. Attainment of groundwater cleanup goals consistent with the site remedy decision documents has been estimated to require between 40 and 70 years. In the interim, exposure pathways that could result in unacceptable risks are being controlled. Successful containment and prevention of direct contact with contamination is required by the Record of Decision and Consent Decree. Deed restrictions regarding future use of groundwater will be implemented as part of the Remedial Action, before cleanup goals are achieved, as required by the Record of Decision and Consent Decree. Groundwater exposure pathways that could result in unacceptable risks are being controlled through extraction wells, to be eventually replaced by the TIC remedy. Groundwater being used by nearby residents is not affected by site contamination. Security for the site property and access restriction is provided by GWTP operations personnel and the Sun / Lomac and GWTP facilities. All threats at the site have been addressed through: site security, control of contaminated groundwater, and treatment of that contaminated groundwater in a treatment plant. Threats presented by sludge and contaminated soil are being addressed through site security and more permanently in 2005 with construction of a soil cover. Protectiveness of the Remedial Action will need to be verified by groundwater sampling and analysis, and short- and long-term monitoring. The remedy at the Bofors-Nobel site currently protects human health and the environment because control of groundwater is being provided by extraction wells, treatment of extracted groundwater is being provided by the GWTP, site personnel and access controls are present to prevent unacceptable exposure to site contamination. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure long-term protectiveness: confirmation of the effectiveness of extraction wells currently on site, better maintenance of those wells to improve pumping efficiency, completion of the TIC remedy design, construction of the designed TIC remedy, issuance of an O.U. #2 ROD, continued short- and long-term monitoring of the TIC remedy, and operation and maintenance of the TIC remedy to achieve and maintain remedy cleanup goals.

**Type of review:**

X Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

**Review number:** ☐ 1 (first) X 2 (second) ☐ 3 (third) ☐ Other (specify)

**Triggering action:**
☐ Actual RA Onsite Construction at OU #____ ☐ Actual RA Start at OU#____
☐ Construction Completion X Previous Five-Year Review Report
☐ Other (specify)

**Triggering action date** ***(from WasteLAN)***: _09 / _30 / _1998_

**Due date** ***(five years after triggering action date)***: _09 / 30 / _2003

## I. INTRODUCTION

The United States Environmental Protection Agency (U.S. EPA) conducted this statutory review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121(c), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Contingency Plan (NCP) Section 300.400(f)(4)(ii), and OSWER Directives 9355.7-02 (dated May 23, 1991), 9355.7-02A (dated July 26, 1994), and 9355.7-03B-P (dated June 2001). The purpose of a statutory five-year review is to evaluate whether a completed remedial action remains protective of human health and the environment at sites where hazardous waste remains on-site at levels that do not allow for unlimited use and unrestricted exposure.

Because the Bofors-Nobel Superfund site (the "site") is a site at which some construction has been completed, is currently undergoing Remedial Design for an amended remedy, and has continuing response work (groundwater pump and treat), the detail level presented in this report is appropriate. This review mainly covers Operable Unit (O.U.) #1 which currently addresses control of contaminated groundwater. Future reviews will cover attainment of groundwater cleanup goals and protection from exposure to sludges in disposal lagoons and contaminated soil, which is anticipated with completion and start-up of the amended remedy. This review also discusses the remedy implemented for the operating plant area of the site, owned by Sun Chemical (formerly Lomac, "Sun/Lomac") and designated as O.U. #2. Although an Interim Remedial Action Plan for O.U. #2 consistent with the O.U. #1 remedy is being implemented, this Five-Year Review Report also discusses potential final remedy decisions for the O.U. #2 area.

This Five-Year Review Report has been prepared by the U.S. EPA Remedial Project Manager in consultation with the Michigan Department of Environmental Quality (MDEQ), using project documents and information supplied by: the Performing Settling Defendants, Sun/Lomac, and the U.S. Army Corps of Engineers (USACE). This is the second five-year review. The triggering action is the first Five Year Review Report of September 30, 1998. This review and supporting documentation will become part of the site record and copies will be placed in the Administrative Record and local repositories for the Bofors-Nobel Superfund site in Muskegon, Michigan.

## II. SITE CHRONOLOGY

| | |
|---|---|
| 1960 | Lakeway Chemicals begins production at the site, using unlined lagoons to dispose of process waste. |
| 1976 | Lagoon disposal was discontinued. |
| Sept. 1976 | Lakeway Chemicals and the State of Michigan sign a Consent Order to address contamination. Eight extraction wells are installed along Big Black Creek.. |
| 1977 | Lakeway Chemicals merges with Bofors Industries. |
| 1980 | Additional extraction wells are installed by Bofors. |
| Dec. 1981 | Bofors-Lakeway merges with Nobel. |

| | |
|---|---|
| July 1983 | Three groundwater extraction wells installed by Bofors (new and replacement wells). |
| Dec. 1985 | Bofors-Nobel files for bankruptcy. |
| June 1986 | site Inspection report issued. |
| Sept. 1986 | Documentation report for Hazard Ranking System (HRS) issued. |
| March 1987 | The operating plant area (O.U.#2) is sold out of bankruptcy to Lomac, Inc. Proceeds of this sale and other Bofors assets are paid to the United States (who places this resource into a Special Account) and Michigan, who uses the money for site response actions including the RI/FS and continued groundwater extraction and treatment. |
| March 1987 | Remedial Investigation/Feasibility Study (RI/FS) started. |
| April 1987 | Three additional extraction wells are installed. |
| Mar. 1989 | Bofors-Nobel site included on the National Priorities List (NPL). |
| Feb. 1990 | RI completed. |
| May 1990 | FS completed. |
| Sept. 17, 1990 | O.U. #1 ROD issued by U.S. EPA. |
| Mar. 1991 | Remedial Design (RD) of O.U. #1 GWTP started by USACE. |
| Nov. 1991 | Supplemental FS completed. |
| May 1992 | Remedial Design (RD) of O.U. #1 GWTP completed by USACE. |
| July 1992 | GWTP construction contract awarded by USACE. |
| July 22, 1992 | Amendment to the O.U. #1 ROD issued by U.S. EPA. |
| Oct. 1992 | Construction of the GWTP starts. |
| March 1993 | RD for the Landfill Remedy portion of O.U. #1 approved by U.S. EPA. |
| May 26, 1993 | USACE postpones indefinitely the bid process for construction of the Landfill Remedy (later cancelled in 1994). |
| July 1993 | U.S. EPA sends Special Notice Letter to PRPs. |
| October 1993 | U.S. EPA instructs USACE to further delay landfill construction to allow for negotiations. |
| June 1994 | General contractor completes on-site testing of GWTP process equipment as required by USACE. |
| July 1994 | Formal alternative Lagoon Area remedy proposal (Total In-Situ Containment, or "TIC") presented to U.S. EPA. |
| Sept. 24, 1994 | GWTP begins treatment of contaminated groundwater. |
| March 1996 | Leaks documented in C-5000 oxidation tanks of GWTP, beginning extended negotiations regarding equipment warranty. |
| May 6, 1996 | Explanation of Significant Difference issued by U.S. EPA to explain cost increases during design and construction of the GWTP. |
| May 31, 1996 | U.S. EPA issues Re-Evaluation of Selected Remedy document. |
| Nov. 1996 | First GWTP walk-through by MDEQ and U.S. EPA. |
| Nov. 20, 1996 | MDEQ awards GWTP operations contract through a Cooperative Agreement. |
| Nov. 13, 1997 | Second GWTP walk-through by MDEQ and U.S. EPA. |
| May 19, 1998 | U.S. EPA and MDEQ declare the GWTP operational and functional. |
| Sept. 30, 1998 | First five-year review (Type Ia) completed by U.S. EPA. |
| July 16, 1999 | Second amendment to the O.U. #1 ROD issued by U.S. EPA. |

| | |
|---|---|
| Sept. 1999 | Phytoremediation Treatability / Feasibility study begins. |
| Nov. 1999 | Consent Decree for RD/RA of TIC Remedy signed. |
| Dec. 2, 1999 | Effective date of Prospective Operator's Agreement (POA) for take-over of GWTP operation by Sun/Lomac partnership. |
| Feb. 2000 | Take-over of Extraction Well Field and GWTP by Sun/Lomac and PSDs. |
| Aug. 2000 | site Management Transition (to PSDs control) approved. |
| Oct. 2000 | Interim Groundwater Monitoring started. |
| August 2002 | TIC Remedial Design Work Plan approved. |
| Dec. 2002 | Eleven (11) new monitoring wells installed and lagoon area soil sampled. |
| March 2003 | Second five-year review process started. |

## III. BACKGROUND

### III.A. Site Physical Characteristics

The Bofors-Nobel site (the "site") is located in the South 1/2 of Section 32, Township 10 North, Range 15 West, generally at 5307 Evanston Avenue in Egelston Township, Muskegon County, Michigan (see Figures 1 and 2). The 85-acre site includes a currently operating specialty chemical production facility, an unused landfill cell, and 10 abandoned sludge lagoons (see Figure 3). The former and operating chemical plant area of the site occupies approximately 39 acres. The southern portion of the site is bounded by Big Black Creek. The site has been divided into two operable units (see Figure 3). The amended Record of Decision has designated the unlined sludge disposal lagoons and underlying contaminated soil and groundwater as O.U. #1. Contamination underneath the operating plant area of the site owned by Sun Chemical (formerly Lomac; "Sun/Lomac") is to be addressed as O.U. #2. After the 1985 to 1987 bankruptcy proceedings, the State of Michigan assumed control of site access and security until the take-over of the remedy by Sun/Lomac and the Performing Settling Defendants in 2000.

### III.B. Site History, Description, Land and Resource Use

The site is a former specialty organic chemical production facility that operated under a series of owners from 1960 until 1985. Lakeway Chemicals, Inc. ("Lakeway") began producing industrial chemicals at the site in or around 1960. The plant produced alcohol-based detergents, saccharin, pesticides, herbicides, and dye intermediates. Unlined lagoons were used for disposal of wastewater, sludge, and other residuals from chemical production until approximately 1976. Wastes disposed of in the lagoons included iron sludge, iron scale, 3,3'-dichlorobenzidine ("3,3-DCB"), benzidine, and other organic wastes, zinc oxide waste, wastes generated from spills, calcium sulfate sludge and detergent wastes. Lakeway Chemical was acquired by Bofors-Sweden, which was then later acquired by Nobel Industries. Nobel Industries was eventually acquired by Akzo Chemical. In 1976, as a result of enforcement action by the State of Michigan ("the State"), extraction wells were installed by Lakeway to capture and contain contaminated groundwater before it reached Big Black Creek. This system of extraction wells has been upgraded and added to, and has continued in operation since 1976. To assist in the prevention of off-site migration of contaminants that may impact Big Black Creek, extraction of groundwater continues. Extracted groundwater is treated in a Groundwater Treatment Plant (GWTP)

constructed by U.S. EPA and MDEQ in 1994. If not contained, the contaminated groundwater discharges into the Creek system, contributing to degradation of this surface water body. Residences in the immediate area of the site are connected to the local public water system and groundwater is not used as potable water. Big Black Creek is a designated trout stream. The contaminants that are the main concern and driving the site's remedy include: Azobenzene, Benzidine, 3,3-Dichlorobenzidine, Toluene, Aniline, and Vinyl Chloride. It is estimated that there are approximately 100,000 cubic yards of chemical sludge remaining in the unlined lagoons, contributing to groundwater contamination.

**III.C. Site Initial Responses**

In the 1970s, the State of Michigan performed investigations and enforcement actions as a result of reports of contamination of Big Black Creek. In 1976, the State of Michigan required Lakeway Chemicals to install groundwater extraction wells to protect the creek. Between 1985 and 1987, the requirement for Bofors to address contamination at the property by incinerating chemical sludge and constructing an on-site landfill cell for incineration residuals came about from the bankruptcy proceedings. In addition, an agreement between the State and the new operating plant owner, Lomac, was created whereby the State maintained the groundwater extraction system and reimbursed Lomac for treatment of that groundwater. The State used a portion of the resources received from the bankruptcy settlement for this agreement. U.S. EPA placed a portion of these resources into a Special Account, which is now being accessed to operate and maintain the current remedy. The site was placed on the National Priorities List (NPL) in 1989 and the State of Michigan (with support from U.S. EPA) completed a Remedial Investigation and Feasibility Study (RI/FS) in 1990, also with bankruptcy settlement resources. In 1990, the Record of Decision was signed, and U.S. EPA and the State of Michigan had USACE concurrently begin design of phased incineration and groundwater pump and treat remedies. USACE completed the GWTP design and started its construction in 1992. In 1992, incineration was removed from the remedy and replaced with excavation and placement of soil and sludge in two landfill cells constructed on-site. Design of the Landfill Remedy phase was completed in 1993, but construction was not started because of new information brought to the attention of U.S. EPA and the State. In 1994, the State-Lomac treatment agreement was discontinued at the commencement of GWTP operation. In 1999, U.S. EPA amended the O.U. #1 remedy for the second time based on new information and entered into a legal agreement (Consent Decree) with the PSDs for implementation of a Remedial Design and Remedial Action of a Total In-Situ Containment (TIC) remedy providing protection similar to the Landfill Remedy. The new information that was the basis for the 1999 ROD amendment included: increased experience (since the 1990 Feasibility Study) with slurry / barrier wall construction and operation, new environmental regulations for the State of Michigan, acceptance by the site PSDs of the requirement that any barrier wall must be "keyed" into a confining layer (approximately 80 to 120 feet below grade), and a commitment by the site PSDs for long-term operation, maintenance, and monitoring of a barrier wall remedy. At the time of this five-year review, the design portion of this TIC RD/RA is proceeding. In 2000, the PSDs and Sun/Lomac assumed responsibility for operation and maintenance of the GWTP and control of site access.

## III.D Site Risks; Basis For Taking Action

### III.D.1. Operable Unit #1; Lagoon Area Soil and Sludges and Groundwater

Risk at the site is summarized by the following excerpts from the O.U. #1 Record of Decision:

> "Air inhalation risks...range from $1.2 \times 10^{-3}$ to $7.9 \times 10^{-9}$, with the lagoon sludge posing the highest risks and berms posing the lowest risks."
>
> "Groundwater ingestion risks...range from $9.9 \times 10^{-1}$ to $3.4 \times 10^{-5}$. [T]otal groundwater ingestion risks resulting from sludge and soil beneath lagoons, soil around lagoons or berms are all above acceptable limits."
>
> "Surface water ingestion risks...assume that the groundwater pumping and treatment system is turned off. The calculated risks range from $1 \times 10^{-2}$ to $3.4 \times 10^{-7}$. [E]ven though the surface water poses risks substantially lower than the groundwater, the risks from surface water ingestion are above the acceptable range."
>
> "The highest excess cancer risks developed were associated with the groundwater exposure pathway. The combined carcinogenic risks reflecting all the contaminants of concern and all exposure pathways of concern are estimated to be approximately $10^{-1}$ excess cancer risk."
>
> "Non-carcinogenic effects are estimated to be insignificant in this operable unit, since the metals in the sludges and soils do not appear to exhibit significant mobility."

Table 1 provides a summary of risks cited in the O.U. #1 ROD and 1999 Second ROD amendment. Sludge and contaminated soil in the Lagoon Area has not been removed or otherwise mitigated, therefore the contaminants and risk remain at unacceptable levels, continuing to warrant remedial action. However, because access to the site and the Lagoon Area is restricted, there are no immediate exposure pathways available to humans.

### III.D.2. Operable Unit #2; Operating Plant (Sun/Lomac) Area of the site

In 1991, a baseline Risk Assessment calculated for the plant area of the site concluded that concentrations of contaminants in soil underneath the Sun/Lomac facility were high enough to present a human health risk for certain exposure scenarios. That Risk Assessment concluded that, for an adult worker in the O.U. #2 area of the site, exposure to contaminated soil presented a health risk as high as $3 \times 10^{-3}$. For an adult who uses the O.U. #2 area for residence, ingestion of groundwater poses a $6 \times 10^{-1}$ risk. Similarly, the non-carcinogenic health hazard for an adult who uses the O.U. #2 area for residence is over 1.

Reasonable future land use for the O.U. #2 area of the site, however, will likely not be residential. An Interim Remedial Action Plan (IRAP) for O.U. #2 consistent with the O.U. #1 remedy is being implemented Actions implemented for the O.U. #2 area IRAP protect people

who currently work in the Sun/Lomac area. No O.U. #2 Record of Decision has yet been issued by U.S. EPA.

## IV. REMEDIAL ACTIONS

### Remedy Selection

### IV.A. Operable Unit #1; Lagoon Area Soil and Sludges and Groundwater

A Record of Decision (ROD) for O.U. #1 was signed on September 17, 1990. The remedy requirements as discussed in the original O.U. #1 ROD were:

- upgrade and maintenance of existing extraction wells to intercept flow of contaminated groundwater which would otherwise enter the Big Black Creek system;
- excavation and on-site thermal treatment of sludges and contaminated soils, and on-site landfilling of treatment residues;
- environmental monitoring to ensure the effectiveness of the remedial action, and;
- construction of an on site groundwater treatment plant for treatment of extracted groundwater.

The O.U. #1 ROD was amended on July 22, 1992 because of: more contaminated material at the site than originally estimated; possible inconsistent incineration treatment of contaminated material with the same level of risk (the larger volume of materials would have lessened the reduction in risk achieved by incineration), and; greater cost and logistics involved with incineration than originally estimated. This amendment to the ROD:

- eliminated incineration as a treatment technology for the site;
- required construction of larger on-site landfill cells for direct placement and containment of sludge and contaminated soils on-site (the "Landfill Remedy"), and;
- continued to require extraction and treatment of contaminated groundwater to restore groundwater to acceptable levels.

On May 6, 1996, U.S. EPA issued an Explanation of Significant Difference (ESD) to outline the circumstances and history of the O.U. #1 GWTP design and construction, and to explain the associated increase in remedy cost.

On May 31, 1996, U.S.EPA issued a Re-Evaluation of Selected Remedy document certifying that the Landfill Remedy selected by the 1992 ROD amendment adequately satisfied remedy selection criteria. Specifically, this document concluded:

- the Landfill Remedy would be an adequately protective remedy if constructed;
- the Landfill Remedy was still the best remedy using the selection criteria, but;
- updates to remediation technology since the time of the ROD amendment could warrant re-evaluation of alternative technologies previously eliminated.

U.S. EPA issued this document after receiving new information that there could be a more effective means to achieve the same cleanup goals as the original selected remedy. The new information included: increased experience (since the 1990 Feasibility Study) with slurry / barrier wall construction and operation, new environmental regulations in the State of Michigan,

acceptance by the site PSDs of the requirement that any barrier wall must be "keyed" into a confining layer (approximately 80 to 120 feet below grade), and a commitment by the site PSDs for long-term operation, maintenance, and monitoring of a barrier wall remedy.

After the conclusions of the 1996 re-evaluation, U.S. EPA issued a second amendment to the O.U. #1 ROD on July 16, 1999. This second ROD amendment altered the site's remedy requirements as follows:

- replacement of excavation and disposal of contaminated source areas in on-site cells with a protective cover and barrier wall containment of the source areas;
- provision for phytoremediation and wetlands within the barrier wall: to enhance immobilization of wastes and control infiltration; and to promote groundwater treatment and by biological means;
- establishment of long term groundwater remediation standards, soil cleanup goals, and requirements for deed restrictions for the site, and;
- containment, extraction, and treatment of groundwater, short- and long-term, including containment and management of groundwater until groundwater remediation standards are met.

This Total In-Situ Containment (or "TIC") remedy is a variation on an in-situ containment alternative that was considered in the original Record of Decision and 1992 ROD Amendment. Re-evaluation was performed primarily because: (1) since the time of U.S. EPA's remedy decision, more information had been developed both on the volume of contaminated soils and sludges and on barrier wall technology (which is included as part of the TIC proposal); and (2) the timing of U.S. EPA's identification and contact with the new PRPs arguably did not allow them a full opportunity to comment on the remedy decisions. The remedy goal of the site is restoration of the aquifer to standards required by Part 201 of the Natural Resources and Environmental Protection Act (Environmental Remediation), PA 451 of 1994, as amended ("Part 201"). The design basis for the TIC remedy is reduction of the on-site contaminants to cleanup criteria associated with a future industrial land use scenario. Construction of the barrier wall is planned for 2004, with construction of the other elements of the TIC remedy to be initiated and planned complete in 2005.

**IV.B. Operable Unit #2; Operating Plant (Sun/Lomac) Area of the site**

As part of the second amendment to the O.U. #1 ROD and the associated TIC RD/RA Consent Decree, an Interim Remedial Action Plan (IRAP) was developed to provide an interim remedy for the O.U. #2 area, not inconsistent with the goals of the O.U. #1 TIC remedy. The O.U. #2 IRAP required asphalt capping of areas of contaminated soil to prevent human exposure, and requires continued sampling and analysis of groundwater within the Sun/Lomac area to ensure consistency with the work being performed for O.U. #1. Additional safety procedures and restrictions on operations and activity in the O.U. #2 area have been implemented for this IRAP. As required by the separate Consent Decree entered into with the State of Michigan, Sun/Lomac has agreed to increase interim response activities as a contingency measure in the event that additional remedial actions (such as excavation or groundwater extraction) are determined to be necessary. In addition, the Sun/Lomac facility has improved its existing wastewater treatment

equipment since the time of the Record of Decision and ROD amendments. Because the O.U. #1 TIC remedy is being designed to capture and treat contaminated groundwater flowing from both O.U. #1 and O.U. #2 areas, the IRAP and current O.U. #2 interim activity do not preclude the possibility of consolidation of O.U. #2 remedy work into the O.U. #1 Remedial Action.

A Record of Decision has not been issued for O.U. #2 because a properly operating O.U. #1 TIC remedy should contain any contaminated groundwater coming from O.U. #2, and chemical production at the Sun/Lomac facility continues (precluding effective removal of contaminated soil located underneath facility buildings). Because the RI/FS and existing remedy decision documents have established that the Sun/Lomac area will eventually need to be addressed, an O.U. #2 ROD must be issued to make a final determination as to the fate of contamination within the O.U. #2 area. For the OU #2 area, excavation of contaminated soils may be a requirement depending on reasonable future land use. However, excavation can not be implemented until such time as the Sun/Lomac facility is no longer in operation. The decision regarding a remedy for O.U. #2 will depend on: the effectiveness of the IRAP already implemented; the effectiveness of the O.U. #1 TIC remedy, and; the operating status of the Sun/Lomac facility. Any remedy decision made for the O.U. #2 area should preserve the ability of Sun/Lomac to continue normal operations.

**IV.C. Enforcement Activity**

Pursuant to CERCLA § 122, U.S. EPA issued Special Notice letters to identified PRPs in July 1993, providing an opportunity for their construction of U.S. EPA's O.U. #1 Landfill Remedy. Most of the PRPs for this site were identified by their limited chemical production contracts with Lakeway Chemicals and Bofors-Nobel. Because of the unique remedy selection and notification processes for this site, and because U.S. EPA agreed to develop the O.U. #1 ESD and Re-Evaluation documents, an extended research and negotiation period was granted. U.S. EPA re-issued Special Notice letters again on May 30, 1997 and negotiations proceeded, resulting in the 1999 RD/RA Consent Decree and ROD amendment for the TIC remedy alternative. In 2000, the Performing Settling Defendants (PSDs) assumed control of the site.

This RD/RA Consent Decree has provision for the reimbursement of some PRP remedy costs from a Special Account set up by U.S. EPA, established with the 1987 Bofors bankruptcy settlement funds. In accordance with the provisions of the Consent Decree, the PSDs may petition U.S. EPA annually for reimbursement from the Special Account for operation and maintenance work by providing detailed supporting documentation (such as invoices and descriptions of the work completed) that the work has been performed. Under the Consent Decree and a Pre-Authorization Decision Document (PDD), the PSDs may also, at established milestone dates, petition U.S. EPA for reimbursement from Superfund for a share of the completed remedial action costs.

In addition, to promote wastewater recycling and reduce the need for pumping of groundwater at and near the site, a Prospective Operator's Agreement (POA) was developed in 1999 between U.S. EPA, MDEQ, the PSDs, Lomac, and Sun Chemical (located adjacent to the site). Sun/Lomac agreed to form a partnership, known as Camus LLC, to take over operations and

maintenance of the GWTP constructed by U.S. EPA and MDEQ. Camus' sole responsibility is operation and maintenance of the wastewater systems present at the Sun / Lomac, and GWTP facilities.

**Remedy Implementation**

**IV.D. Remedy Construction / Implementation Activities, Issues and Recommendations**

In March 1991, through an Inter-Agency Agreement (IAG), U.S. EPA authorized the U.S. Army Corps of Engineers (USACE) to begin Remedial Design activity. In May 1992, the design of the GWTP was completed. USACE awarded a contract for construction activities for the first phase of the O.U. #1 remedy (the GWTP) in October 1992. The capacity of the GWTP was designed to treat the maximum possible flow rate expected from the Landfill Remedy. In September 1994, after appropriate testing, treatment of contaminated groundwater started. The GWTP was designed to discharge to Big Black Creek. Until recycling of treated water to Sun Chemical was initiated, the GWTP successfully met surface water discharge standards established by the MDEQ. The complexity of the GWTP system resulted in an extended shakedown period, and the GWTP was declared fully operational and functional by U.S. EPA and MDEQ on May 19, 1998. As of early 2000, with Camus' take over of operation and maintenance, treated water from the GWTP is being re-directed to Sun Chemical for use in their production processes.

The RD for the Landfill Remedy was approved in March 1993 by U.S. EPA. Landfill construction was delayed in order to develop the 1996 remedy re-evaluation document and consider the TIC remedy made available after landfill design was completed. As of the writing of this Five-Year Review Report, design activity for the barrier wall component of the remedy is under way, and construction of the barrier wall component of the remedy is planned to be initiated and completed in 2004. Construction of other components of the TIC remedy are planned to be initiated in 2005.

The groundwater pump and treat phase of the O.U. #1 remedy continues to be operated by the PSDs and Camus. With isolated landfill containment of source contaminant materials, it was once estimated that approximately 40 years of pumping would be needed to achieve acceptable restoration of groundwater. Implementation of the TIC remedy will increase this period because contaminated source material will continue to be in contact with groundwater, and the natural and passive treatment and extraction technologies included as the TIC remedy will require more time to reach cleanup goals.

For O.U. #2 areas, asphalt capping of contaminated soil areas has been completed and groundwater sampling is ongoing. No sooner than 2004, a remedy decision for O.U. #2 will be issued by U.S. EPA after the containment effectiveness of the barrier wall component of the O.U. #1 TIC remedy is measured. In the mean time, threats posed by the O.U. #2 area have been mitigated consistent with O.U. #1 activity.

Table 2 summarizes the remedy implementation Issues and Recommendations identified during the five-year review process.

### IV.E. Final Inspection - Certification of Operational and Functional Status

The extraction wells and GWTP were declared fully operational and functional by U.S. EPA and MDEQ on May 19, 1998. Operational and functional status had been delayed due to the complexity of extra treatment technologies installed in the GWTP. In addition, repetitive leaking in process vessels in the treatment train required repair under warranty. On November 8, 1996, approximately 2 years after commencement of the treatment of contaminated groundwater, U.S. EPA and MDEQ inspected the GWTP for incomplete work items. USACE had already certified the delivery, installation and preliminary testing of the treatment process equipment before the initial start-up in 1994. The most significant problem was leakage from the C-5000 oxidation tanks, the operation of which was guaranteed by the supplying vendor. Chronic leak incidents occurred in early 1996 and the tanks were replaced in late 1997 after extended negotiations over warranty provisions. A second U.S. EPA and MDEQ inspection occurred on November 13, 1997, and the facility was declared operational and functional on May 19, 1998. The inspections were performed jointly by U.S. EPA and MDEQ to identify substantive incomplete work items, and were subsequently resolved by USACE. Appropriate quality assurance and quality control was performed during all phases of remedy construction. Throughout construction activities for all operable units, there has been monitoring of contaminated media.

As mentioned previously, design of the O.U. #1 TIC remedy is under way as of the writing of this Five-Year Review Report. It is anticipated that the TIC remedy will not achieve operational and functional status earlier than 2005. This time period will be necessary to ensure that enough data has been gathered to certify the effectiveness of the vegetative treatment and containment systems in O.U. #1 areas. As part of the Remedial Design of the TIC, procedures are being developed to ensure adequate quality assurance and quality control during construction of the TIC. In addition, design construction, operation, maintenance, and monitoring of the remedy by the PSDs and Camus and regular oversight by MDEQ and USACE (as requested by U.S. EPA) provides an on-site presence that assists in the protection of human health and the environment.

No final remedy decision has been made by U.S. EPA regarding O.U. #2. Requirements of the O.U. #2 IRAP have been implemented under the enforcement authority of the MDEQ. The MDEQ project manager ensured adequate quality assurance and quality control by monitoring each step of the IRAP.

### System Operation and Operation and Maintenance

### IV.F. Achievement of Remedy Cleanup Goals

Table 4 provides a listing of historical data showing the contaminants found in site soil and cited in the Amended O.U. #1 ROD. Table 5 provides a limited comparison of groundwater contaminants cited in the O.U. #1 ROD against cleanup criteria. Table 6 shows a limited summary of contaminants found in the lagoon area. Table 7 provides a limited example of the reduction in concentrations for some groundwater contaminants over the time period of remedy activity to date. Table 8 demonstrates that the GWTP successfully treats groundwater and meets

permit limits established by MDEQ, and has been in compliance since the start of GWTP operation in 1994.

As shown by these tables, implementation of the O.U. #1 remedy to date has assisted in decreasing contaminants in groundwater. Established well locations and pumping at the site assist in controlling migration of contaminated groundwater from the site toward Big Black Creek. Because site access is restricted, the unlined lagoons have not changed for many years and a decrease in site contaminant concentrations has occurred. This is likely from natural mechanisms, such as biological activity and contaminants leaching from soil into groundwater through precipitation, later collected by the operating groundwater extraction wells.

Although the site's remedy goal is restoration of the groundwater aquifer to acceptable levels, and there has been a reduction in site contaminants, the O.U. #1 remedy has not yet been operating long enough to realize this goal. In addition, the O.U. #1 TIC remedy has not yet been completely designed or constructed. It is anticipated based on the contaminant reduction and preliminary data collected that the remedy goal can eventually be achieved. The second amendment to the O.U. #1 ROD stated that the TIC remedy will be protective of human health and the environment, will comply with Federal and State requirements legally applicable or relevant and appropriate to the Remedial Action, and will be cost effective. The ROD requires principal threat wastes to be reliably controlled in place. In addition, the phytoremediation and wetlands components of the remedy provide treatment of these principal threat wastes consistent with the statutory preference for treatment as a principal element. Although the TIC remedy will require a longer time period to achieve cleanup goals, its cost effectiveness and more natural remediation mechanisms make it equal to or better than the original remedy selected by U.S. EPA, for a reasonably equivalent degree of containment. Literature suggests that for the nature and extent of contamination present at the site, treatment mechanisms provided through vegetation may reduce site contamination to acceptable levels within an approximate time of 30 to 70 years, with the most appreciable reduction occurring in the initial 20 years.

**IV.G. Operation and Maintenance (O&M)**

At the time the POA was signed, U.S. EPA and MDEQ (the "Agencies") had completed construction of the GWTP and started Long Term Response Action (LTRA). Eventually in 2008, MDEQ would have been responsible for 100 percent of O&M. With approval of the POA and the take-over of GWTP operations by Camus, the Agencies will no longer have the responsibility of GWTP O&M. In addition to operating the extraction and treatment processes, LTRA and O&M tasks for the GWTP and extraction systems will include:

- procurement of utilities such as gas, water, communications, and electricity;
- extraction well cleaning and preventive maintenance;
- re-development of wells as needed;
- continued groundwater sampling and analysis;
- general repair, maintenance, and minor improvements to the system(s) and GWTP buildings and grounds, and;

- repair and upgrade of: groundwater collection piping and valving, emission control equipment, residuals handling equipment, monitoring wells, and extraction well vaults and associated equipment.

Because of the Consent Decree entered into by U.S. EPA and the PSDs, O&M of the lagoon area TIC remedy is also no longer the direct responsibility of U.S. EPA or MDEQ. With approval of the Consent Decree, the PSDs have agreed to a long term commitment ensuring that O&M of site mitigative measures continues for a time period as long as necessary to ensure all remedial objectives are met and maintained. U.S. EPA and MDEQ will also continue to monitor the site's activities to make sure that Consent Decree requirements are being satisfied.
O&M tasks for the TIC remedy will include:

- upkeep, monitoring, and routine inspection of the vegetative portion of the TIC remedy, including introduction of nutrients and irrigation, if needed;
- regular inspections of the O.U. #1 lagoon area cover to assure the protectiveness of the cover, to prevent disturbance and exposure to contaminated soils remaining underneath the cover, and to assess whether adverse ecological effects are occurring at the site;
- removal of vegetation if needed, and;
- upkeep of any additional extraction system installed to augment groundwater containment provided by the barrier wall.

## IV.H. Costs

The O.U. #1 Record of Decision provided the following general cost estimate for the lagoon area remedy (thermal treatment, landfilling, pumping and treating of groundwater in a treatment plant): $ 65,752,000 capital cost and $ 313,000 annual O&M costs. This was revised in the 1992 ROD Amendment to reflect elimination of thermal treatment: $ 44,584,000 capital cost and $355,000 annual O&M costs.

Capital cost of the GWTP constructed by U.S. EPA and MDEQ completed in 1994 was approximately $16,600,000 and included:

- the GWTP design from 1991-1992;
- GWTP construction from 1992-1994;
- GWTP start-up from 1994-1996; and
- the first "operations" contract from 1996 to January 2000. This "operations" contract was awarded by MDEQ on behalf of the Agencies using Cooperative Agreement funds authorized by U.S. EPA at a 90 percent Federal / 10 percent State cost sharing.

Current annual O&M costs for the GWTP and extraction wells are approximately $500,000 to $600,000 per year, which is less than originally estimated in 1992.

Tables 9 through 11 provide a detailed break down of capital and O&M cost estimates for all implementation phases of the O.U. #1 TIC remedy (including Contingent Remedial Actions or "CRAs" ). It is anticipated that 8 years will be required until the TIC remedy is designed, constructed, started up, and vegetative components have matured. Costs (including cost estimate contingencies) are summarized as follows:

| | | |
|---|---|---|
| TIC remedy Remedial Design: | | $ 5,450,000 |
| TIC remedy Minimum Construction Requirements: | $ 10,189,990 | |
| Additional Construction Capital for CRAs: | $ 4,594,540 | |
| Total (Maximum Construction Capital Cost): | $ 14,784,530 | |
| Minimum Project Cost (RD plus Minimum Construction): | | $ 15,639,990 |
| Maximum Project Cost (RD plus Maximum Construction): | | $ 20,234,530 |
| Annual O&M and Monitoring - Yrs 1 to 3: | $ 830,000 | |
| Annual O&M and Monitoring - Yrs 3 to 8: | $ 770,000 | |
| Annual O&M and Monitoring - Yrs 8 to 33: | $ 570,000 | |
| Annual O&M and Monitoring - Yrs 33 to 103: | $ 353,000 | |
| Present Worth of Annual O&M & Monitoring (including contingency): | $ 14,932,160 | |
| Minimum Net Present Worth of Project: (not including design or EPA / MDEQ cost) | $ 25,122,150 | |
| Maximum Net Present Worth of Project: (not including design or EPA / MDEQ cost) | $ 29,716,690 | |

Implementation of the O.U. #2 IRAP has been estimated at approximately $100,000 to $200,000, with an annual cost of approximately $20,000. It is anticipated that any remedy selected for O.U. #2 by U.S. EPA in a Record of Decision may not be as costly. Contingency funding exists for the parties addressing O.U. #2 in the event remedial action is needed beyond IRAP requirements.

## V. PROGRESS SINCE LAST FIVE-YEAR REVIEW

On September 30, 1998 a Five-Year Review Report for the site was issued by U.S. EPA and certified that the Remedial Action implemented at the site to date was effective and remained protective of human health and the environment:

> "... at this point in time, the remedy selected for this site remains protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the Remedial Action, and is not inconsistent with additional Operable Units for this site or any potential future Remedial Actions."

The GWTP had achieved operational and functional designation earlier in 1998 and all requirements of Applicable, Relevant or Appropriate Requirements (ARARs) for the remedy were being met. The 1998 Five-Year Review Report showed a decrease in contaminant concentrations and recommended: continuation of groundwater Remedial Action activity, issuance of the second ROD Amendment, and design and construction of the TIC remedy. The

1998 five-year review was completed at the same time as negotiations were being conducted with site PRPs, as preliminary information was being compiled for the second ROD amendment, and while GWTP operations were being refined and optimized.

Since 1998, a Consent Decree was signed transferring responsibility for the site remedy to potentially responsible parties. The second O.U. #1 ROD Amendment fundamentally changing the Lagoon area portion of the O.U. #1 remedy was also signed and issued. In 2002, the TIC Remedial Design Work Plan was approved and data collection and design for the TIC remedy has proceeded. In the ROD amendment decision document of 1999, U.S. EPA reviewed and revised ARARs, incorporating environmental regulations that were changed in 1995 for the State of Michigan. Consequently, the site's remedy goals for O.U. #1 were updated to reflect a more reasonable future land use scenario. Currently ongoing activities at the site include: the Long Term Response Action (LTRA) for groundwater, routine O&M of the GWTP and well field, interim groundwater monitoring, and data collection / design work for the TIC remedy.

## VI. FIVE-YEAR REVIEW PROCESS

### VI.A. Administrative Components

The project coordinator for the PRPs for this site was notified of the formal five-year review process by electronic mail in March 2003. MDEQ and USACE are active participants in the monitoring of the progress of this remedy, and were also recipients of electronic mail messages informing them of the five-year review for the site. Representatives of these organizations were involved in the site inspection and drafting of this Five-Year Review Report.

Because the ARARs for the site were reviewed in detail and revised with the July 1999 ROD amendment, there was only a brief review for confirmation that these ARARs remain valid. Cleanup goals put forth in the 1999 ROD amendment were based on State of Michigan regulation (Part 201) using an industrial future land use for the site. In addition, surface water and groundwater-surface water interface standards will be considered for the design and operation of the portions of the TIC remedy that will affect the Creek ecosystem.

Institutional controls will eventually need to be implemented in the form of deed restrictions. The 1999 Consent Decree requires the Performing Settling Defendants to implement restrictions on the use of the property, as needed. The PSDs, with support from U.S. EPA and MDEQ, will update the deed to the site property to reflect a future land use consistent with the ROD, and will include any other land or site use restrictions to ensure no unacceptable human exposure to contaminants remaining on site. Since the Bofors bankruptcy, access to the portions of site property that do not include the operating Sun/Lomac facility had been controlled by the State of Michigan. More recently, through their on site presence, the PSDs, Lomac, Sun Chemical, and Camus (GWTP operations contractor) have restricted access and use of the site property. This will continue with the remedy's construction and operation.

## VI.B. Community Notification and History of Involvement

Most of the area around the site is undeveloped forest, with some industrial and commercial facilities interspersed. Residential areas nearby are semi-rural, with approximately 500 residents in a one-mile radius of the site. Site contamination exists within the site boundary and no private residential wells near the site are affected. U.S. EPA published notice of the completion of the FS and of the proposed plan for remedial action for the First Operable Unit on July 21, 1990, in a major local newspaper of general circulation. U.S. EPA subsequently proposed to amend the proposed remedial action for Operable Unit One on two separate occasions, and notices of the proposed revisions to the remedial action decision were published on April 6, 1992 and June 17, 1998. In addition to the meetings for public comment required in the procedure for formal site decisions, U.S. EPA and MDEQ have been available several times for informal community forums. There has not been active interest in the site from the community since the time of the last remedy decisions approximately 4 years ago. Therefore, no community interviews were conducted for this five-year review. However a notice regarding the five-year review process and the availability of this report to the general public has been placed in a newspaper of local interest, the Muskegon Chronicle.

Upon completion of this report, a notice regarding its availability to the general public will be provided in a local newspaper, the Muskegon Chronicle. This Five-Year Review Report will be placed with all other site related documents as part of the Administrative Record File, available for public inspection at the following locations:

Egelston Township Hall
5382 East Apple Avenue
Muskegon, MI 49442

Hackley Library
316 West Webster Street
Muskegon, MI 49440

The Administrative Record may also be reviewed at:

U.S. EPA Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

U.S. EPA Region 5 will provide further community involvement events if additional community interest results from this five-year review.

## VI.C. Document Review

Because Superfund activity at this site started in 1988 and because of many site assessments, evaluations, and decision documents, there are numerous documents available for the five-year review process. This Five-Year Review Report is based on quarterly monitoring reports, monthly operation reports, historical and current data, and supplemental evaluations of that data. The documents that were reviewed for this five-year review were: the RI/FS, the baseline Risk Assessment, groundwater monitoring reports for the GWTP and Landfill Remedy designs, GWTP operations reports, information gathered for the preliminary TIC remedy conceptual

proposal, Interim Monitoring reports generated by the PSDs for the TIC Remedy RD, groundwater monitoring for the Sun/Lomac area as required by the IRAP, and other data and evaluations for the site.

A detailed ARARs analysis was performed for the 1999 ROD amendment, resulting in a change to the site's cleanup goals. Because the State of Michigan standards selected at that time have not been changed, ARARs were only briefly reviewed for this five-year review. The base line risk assessment calculated from the Remedial Investigation was also reviewed at this time. Because the risk originally calculated for the site was high, the contamination source for the site has essentially remained intact since the time of the site's risk assessment, and because site contamination in groundwater has been reduced by no more than one order of magnitude, there still remains a level of human health risk at the site unacceptably high enough to continue Remedial Action. Therefore, the site's risk assessment was reviewed to confirm its continued applicability, but not revised. Although concentrations of site contaminants will be decreased over time to achieve cleanup criteria, any contamination remaining at the site represents a potential future threat to human health and the environment. The Consent Decree provides assurance from the PSDs that any threat remaining at the site will be addressed by additional remedial action (if needed). The PSDs will also operate and maintain the site remedy for as long as necessary to ensure that cleanup criteria are maintained once they are achieved.

**VI.D. Data Review**

Much of the data generated for the site was reviewed in detail during the development of the 1999 ROD amendment to determine the effectiveness of the site remedy and the progress toward removing site contamination. Since 1999, the PSDs have been collecting interim monitoring data for groundwater. In 2002, the PSDs collected soil samples for geological analysis and to help determine placement of the Barrier Wall portion of the TIC Remedy. In late 2002, additional monitoring wells were installed near Big Black Creek to assist in monitoring containment effectiveness of the TIC remedy and to assist in the design and placement of the Barrier Wall. These new monitoring wells were installed using Vertical Aquifer Sampling (VAS), which provides groundwater samples at distinct depths below grade. Data from the RI/FS completed in 1989 was also reviewed as well as GWTP and Landfill Remedial Design data gathered from 1992 to 1994. Tables 3 through 8 summarize the progress of the site's cleanup.

**VI.E. Site Inspection**

On May 23, 2003, U.S. EPA, MDEQ, USACE, the PRP consultant, representatives of Sun Chemical and the GWTP operations firm were present on site for a site inspection specific for the five-year review. Tasks for this site visit were: inspection of all areas for any changes to the site's status and general housekeeping (including site security and any "new" evidence of improper disposal), inspection of phytoremediation pilot areas (installed for TIC RD preliminary data), inspection of the GWTP building and process equipment, review of GWTP operations and optimizations, inspection of extraction well areas, and discussion of extraction well operation, maintenance and optimization. Nothing unusual was observed during this inspection.

From 1992 to early 2000, GWTP construction, start-up and operation was the responsibility of U.S. EPA and MDEQ, requiring monthly site visits. During that time, there were full time operations personnel present at the GWTP, and no major problems occurred at the site. The U.S. EPA RPM, MDEQ, and USACE have been present on site intermittently since 1999, for routine visits.

Within the past 4 years, no new issues or information have arisen that question the effectiveness of the remedy required by site decision documents. In this time period, except for the reduction in contaminant concentrations, and less frequent cleaning of groundwater extraction wells, there have not been any fundamental changes to the site since the Records of Decision. Camus personnel are present at the GWTP during regular business hours, monitoring the site, remedy, and design activities on a regular basis. This limits access to contaminated areas of the site. In addition, USACE has been assigned to perform oversight of site activities by the PSDs or their contractors.

Reduced frequency of cleaning of groundwater extraction wells has reduced pumping efficiency due to fouling. However, extraction wells at the site are still capable of providing control of groundwater. For example, a review of historical groundwater data for benzidine at the MW-60 well cluster (nearest to Big Black Creek) shows a maximum benzidine level of 2600 ppb in the year 1993, when more frequent well cleaning occurred. In December 2002, a benzidine level of 400 ppb was demonstrated at the MW-60 cluster, suggesting that the extraction system is still able to control groundwater flow toward Big Black Creek, and also contributes to the reduction of site contaminants.

A thorough analysis of groundwater elevations to precisely demonstrate the effect of the extraction wells has not been performed at the site in recent years. As part of the Remedial Design currently under way, more detailed analyses of groundwater data is being performed, with the goal of ensuring that no contaminant reaches Big Black Creek at unacceptable levels. In addition, implementation of the TIC remedy will include increased and more detailed monitoring than the interim monitoring currently performed.

## VII. TECHNICAL ASSESSMENT

**Question A: Comparison of remedy operations, remedy design and remedy construction against decision documents.**

As required by the original Record of Decision, the GWTP has been effective in reducing the amount of site contaminants reaching the Creek. Operation of extraction wells is intended to intercept groundwater before reaching Big Black Creek. The extraction wells are successful in controlling migration of contaminated groundwater, however site data indicates that some contamination still exists near the Creek. Groundwater cleanup goals have yet to be reached, and it is anticipated to require another approximately 40 to 70 years of containment and treatment to achieve. As long as the extraction system operates, and personnel and access control measures are present on site, there is no threat of unacceptable human exposure to site contaminants.

Tables 3 through 7 provide limited examples of contaminant reduction over the time period of remedy activity to date. Table 8 shows the effectiveness of the treatment system in meeting discharge limits.

The TIC remedy phase of O.U. #1 is being designed to provide groundwater containment similar to the current extraction well system, with an added wetlands treatment component to allow flow of treated water to the Creek system. In addition, the TIC remedy's protective soil cover is being designed to eliminate the direct contact exposure pathway. The phytoremediation component within the containment structure is anticipated to assist in immobilizing and reducing contaminants leaching from the soil. It is anticipated the TIC remedy will achieve protection of human health and the environment immediately by eliminating exposure pathways as required by the 1999 O.U. #1 ROD amendment. The TIC remedy will be closely monitored to ensure detection of any problems.

The IRAP for OU #2 areas has eliminated exposure to contaminated soil and is not inconsistent with the site-wide remedy goals established by the 1999 O.U. #1 ROD amendment. A final Record of Decision for O.U. #2 has not yet been issued by U.S. EPA, because: a properly operating O.U. #1 TIC remedy should contain any contaminated groundwater coming from O.U. #2, and; chemical production at the Sun/Lomac facility continues, precluding effective removal of contaminated soil located underneath facility buildings. Any remedy decision made for the O.U. #2 area should preserve the ability of Sun/Lomac to continue normal operations.

**Question B: Validity of exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy against current conditions.**

Because U.S. EPA risk assessment procedure and calculation has not changed since the O.U. #1 Records of Decision and amendments, and because there has been no change in the population of residents near the site, the exposure assumptions for this site have not changed since the original baseline risk assessment. Although current site conditions show a reduction in contaminant levels, risk presented by lagoon sludge, contaminated soil, and contaminated groundwater still exists at a high enough level to warrant continued Remedial Action. The 1999 O.U. #1 ROD amendment updated the site's Remedial Action Objectives and site cleanup goals to reflect changes to State of Michigan standards implemented in 1995. Site cleanup goals are now consistent with cleanup criteria associated with a future industrial land use scenario. Any contamination remaining at the site represents a potential future threat to human health and the environment. The Consent Decree provides assurance from the PSDs that any threat remaining at the site will be addressed by additional remedial action (if needed). The PSDs will also operate and maintain the site remedy for as long as necessary to ensure that cleanup criteria are maintained once they are achieved.

Because contaminated soil still exists in O.U. #2 areas, and contamination may be leaching through underlying O.U. #2 soils to groundwater underneath, there is still a risk present. O.U. #2 IRAP implementation has alleviated the risk associated with direct contact to contaminated soils. If the O.U. #1 TIC Remedy operates as intended, however, containment of O.U. #2 groundwater contamination will occur in combination with that of O.U. #1.

**Question C: Assessment of new information that may question the protectiveness of the remedy.**

New information regarding: changes to State of Michigan environmental standards; updated containment technologies, and recommendations and long-term commitments from site PRPs resulted in the issuance of the 1999 ROD amendment.

The scope of the TIC remedy includes aspects of protectiveness that have already been analyzed by U.S. EPA for the original O.U. #1 ROD, the 1992 ROD Amendment, the 1996 ESD, the 1996 Remedy Re-Evaluation, and the 1999 Second ROD Amendment. There are provisions within the scope of the TIC Remedy and Consent Decree that cover any threats to ecological systems in and around the site. The TIC Remedy scope provides opportunities to assess ecological protections and controls as needed. In addition, the TIC remedy requires development of detailed short- and long-term monitoring programs to ensure the remedy's effectiveness and protection of human health and the environment.

Within the past 4 years, no new issues or information have arisen that question the protectiveness of the remedy established by site decision documents. Reduced frequency of cleaning of groundwater extraction wells has reduced pumping efficiency due to fouling. However, extraction wells at the site are still capable of providing control of groundwater, and on-site personnel and access control measures prohibit unacceptable exposure to site contamination. As part of the design of the TIC remedy, data will be provided to confirm the containment effectiveness of the extraction wells.

**Technical Assessment Summary**

Although cleanup goals have not yet been reached, the remedy as constructed is functioning as intended by the site decision documents. The exposure assumptions for this site have not changed. Current conditions show a reduction in contaminant concentrations. Since the time of the 1999 O.U. #1 second ROD Amendment, there has been no additional information that may question the protectiveness of the remedies for any Bofors-Nobel operable unit. Current Remedial Design activity uses the requirements of the 1999 O.U. #1 ROD amendment as the design basis. Design of the TIC remedy is proceeding.

## VIII. ISSUES

During this five-year review process, there were no immediate problems identified with the current status of the site and site remedy. Revisions to ARARs for this site occurred with the 1999 second ROD Amendment. Development of that 1999 decision document also considered site remediation and contaminant reduction that started with the initial groundwater extraction in the 1970s. A decrease in the concentrations of contaminants in groundwater has been documented. Annual cost for the site remedy is less than what was estimated in 1992.

The 1999 Consent Decree and ROD amendment and transfer of site responsibility from U.S. EPA and MDEQ to the PSDs has delayed implementation of the site remedy. However, the amended site remedy will be more cost effective and will provide a more natural containment and treatment method. Other delay occurred with development of a GWTP operations agreement between U.S. EPA, MDEQ, and Sun / Lomac because of the innovative nature of transferring a government constructed facility for an ongoing Superfund groundwater remedy to a private party. Take over of the GWTP by Sun / Lomac / Camus has alleviated annual costs for U.S. EPA and MDEQ for the treatment portion of the O.U. #1 groundwater remedy. Due to improperly functioning GWTP process equipment, other delays occurred in declaration of operational and functional status for the O.U.#1 GWTP.

A Record of Decision for Operable Unit #2 should not be developed until the effectiveness of the O.U. #1 TIC Remedy can be determined. The decision regarding a remedy for O.U. #2 will depend on: the effectiveness of the O.U. #2 IRAP already implemented; the effectiveness of the O.U. #1 TIC remedy, and; the operating status of the Sun/Lomac facility. It is possible that an O.U. #2 remedy may range from an "active" remedy such as demolition of facility buildings and soil excavation (if production ceases for any reason), to a presumptive remedy of monitoring and institutional controls (such as deed restrictions), to a simple administrative solution such as consolidation of both Operable Units into one (O.U. #1). Any remedy decision made for the O.U. #2 area should preserve the ability of Sun/Lomac to continue normal operations.

Remaining issues at the site are: investigation and improvement / maintenance of extraction wells to confirm and (possibly) improve control of groundwater, TIC remedy design completion, TIC remedy construction and start-up, measurement of TIC remedy effectiveness, development and approval of a Record of Decision for Operable Unit #2, implementation of the recommendations of the O.U. #2 ROD, monitoring of both O.U. #1 and O.U. #2 remedies to determine their effectiveness, operation and maintenance of both O.U. #1 and O.U. #2 remedies, and certification of achievement of site remedy cleanup goals (for eventual deletion of the site from the National Priorities List). Table 2 lists the issues identified by the five-year review process.

## IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The first phase of the O.U. #1 site remedy (GWTP construction) has been constructed, was declared operational and functional in 1998, and has been successfully treating contaminated groundwater for nearly 9 years. Site security and access restriction to the site is currently provided by GWTP operations personnel and because individuals can only gain access through the Sun / Lomac and GWTP facilities. Remedy operations ensures a continuous on site presence. There is a decrease in contaminant concentrations throughout the known contaminant plume and contaminated soils will soon be contained by a surrounding barrier wall and soil cover. The current pump and treat remedy has provided effective control of groundwater. The TIC remedy will provide more passive groundwater containment and treatment, replacing extraction wells. The TIC remedy will ensure better cost effectiveness when compared to previous remedy decisions for the site. ARARs for the site were updated in 1999 by the second ROD amendment. Legal activity and negotiations for this site resulted in some delay to

implementation of remedy work. Current Remedial Design work is using future non-residential use of site property as the design basis. Deed restrictions will be implemented as part of the Remedial Action scope defined in the Consent Decree and agreed to by the site's Performing Settling Defendants. Operation and maintenance for the site will be managed by Sun/Lomac, Camus, and the PSDs as part of the Remedial Action.

It is recommended that data being collected for the RD be reviewed to confirm the containment effectiveness of the extraction wells on site, and extraction well maintenance be improved (as needed) to increase pumping efficiency. The O.U. #1 Remedial Design should be completed using a phased approach. Portions of the TIC remedy can be designed and construction started in 2004, while other portions of the RD can be approved later in 2004. Completion of construction of the O.U. #1 remedy is targeted for 2005, with the vegetative portions of the remedy maturing by approximately 2008 to 2010. Detailed monitoring of soil, groundwater, and surface water will be implemented as part of this remedy to establish its effectiveness and continued protection of human health and the environment. The O.U. #2 ROD is targeted for development and completion later in 2004. U.S. EPA and MDEQ will continue to monitor the site's progress and approve each phase of the site remedy. An approximate schedule for implementation of these recommendations is shown in Table 12.

## X. STATEMENT OF PROTECTIVENESS

The completed portion of the O.U. #1 remedy is protective of human health and the environment by ensuring control of contaminated groundwater. The portion of the amended O.U. #1 remedy currently being designed is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals, through containment technology enhanced with phytoremediation. Control of contaminated groundwater will continue at the site for as long as necessary until groundwater cleanup goals are achieved. Attainment of groundwater cleanup goals consistent with the site remedy decision documents has been estimated to require between 40 and 70 years. In the interim, exposure pathways that could result in unacceptable risks are being controlled. Successful containment and prevention of direct contact with contamination is required by the Record of Decision and Consent Decree. Deed restrictions regarding future use of groundwater will be implemented as part of the Remedial Action, before cleanup goals are achieved, as required by the Record of Decision and Consent Decree. Groundwater exposure pathways that could result in unacceptable risks are being controlled through extraction wells, to be eventually replaced by the TIC remedy. Groundwater being used by nearby residents is not affected by site contamination. Security for the site property and access restriction is provided by GWTP operations personnel and the Sun / Lomac and GWTP facilities. All threats at the site have been addressed through: site security, control of contaminated groundwater, and treatment of that contaminated groundwater in the GWTP. Threats presented by sludge and contaminated soil are being addressed through site security and more permanently in 2005 with construction of a soil cover. Protectiveness of the Remedial Action will need to be verified by groundwater sampling and analysis, and short- and long-term monitoring.

The remedy at the Bofors-Nobel site currently protects human health and the environment because control of groundwater is being provided by extraction wells, treatment of extracted

groundwater is being provided by the GWTP, site personnel and access controls are present to prevent unacceptable exposure to site contamination. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure long-term protectiveness: confirmation of the effectiveness of extraction wells currently on site, better maintenance of those wells to improve pumping efficiency, completion of the TIC remedy design, construction of the designed TIC remedy, issuance of an O.U. #2 ROD, continued short- and long-term monitoring of the TIC remedy, and operation and maintenance of the TIC remedy to achieve and maintain remedy cleanup goals.

## XI. NEXT REVIEW

The next review will be by June 30, 2008, approximately five years after the approval of this Five-Year Review Report. In the interim, the TIC Remedial Design will be completed, the TIC Remedy constructed, and an operational period of approximately 3 to 4 years will have transpired.

## TABLE 1 - SUMMARY OF RISK; O.U. #1 ROD AND 1999 SECOND ROD AMENDMENT; BOFORS-NOBEL SITE

| EXPOSURE PATHWAY | RESIDENTIAL CARCINOGENIC RISK IDENTIFIED IN 1990 ROD[1] |
|---|---|
| Groundwater | $3.4 \times 10^{-5}$ to $9.9 \times 10^{-1}$ [3] |
| Soil Ingestion | $2 \times 10^{-10}$ to $2 \times 10^{-3}$ [4] |
| Soil Direct (Dermal) Contact | $7.9 \times 10^{-9}$ to $1 \times 10^{-5}$ |
| Air | $7.9 \times 10^{-9}$ to $1.2 \times 10^{-3}$ [5] |
| Surface Water (Computer Modeled) | $3.4 \times 10^{-7}$ to $1 \times 10^{-2}$ [6] |
| CUMULATIVE (TOTAL) RISK | $3.4 \times 10^{-5}$ to $1.0 \times 10^{-0}$ |

**FOOTNOTES FOR TABLE 1**

1 Information from September 1990 Record of Decision and February 1990 Remedial Investigation (RI) Report (repeated in 1999 ROD amendment).

2 Risk uses a basis of a 70 year life time. A $1.0 \times 10^{-6}$ cancer risk value corresponds to a 1 in 1,000,000 chance that an individual develops cancer as a result of exposure to these concentrations of contaminants over a period of 70 years. Similarly, $1.0 \times 10^{-5}$ corresponds to a 1 in 100,000 chance, $1.0 \times 10^{-4}$, 1 in 10,000, and so on. U.S. EPA may perform a Remedial Action if cancer risks are greater than $1.0 \times 10^{-4}$, or a Hazard Index of 1.0 or greater.

3 Calculated in 1990 by computer models ("SeSOIL" and "AT123D") which simulated contaminant release as leachate from soil and sludge.

4 Taken from February 1990 Remedial Investigation (RI) Report, Chapter 6. Original risk calculations based on limited availability of carcinogenic potency information, and computer models noted in Footnote (3). A fundamental requirement for this remedy is a lagoon area cover that must prevent all unacceptable contact with contaminated sludge and/or soil.

5 Calculated in 1990 by a computer model ("ISCLT"), that assumed "worst-case" volatilization of organics from lagoon area sludge.

6 Surface water risks calculated in 1990 by a computer model ("EXAMS-II") that simulated the fate of contaminants in groundwater discharging to a surface water body. State of Michigan Groundwater-Surface Water Interface (GSI) Standards will be the performance criteria for this remedy and will insure protection of Big Black Creek. In addition, the continuation of adequate capture of contaminated groundwater before discharge to the Creek (which has been in operation since the mid-1970s) is a fundamental requirement for this remedy, and thus the surface water exposure pathway will continue to be eliminated.

## TABLE 2 - SUMMARY OF FIVE YEAR REVIEW ISSUES, RECOMMENDATIONS, AND FOLLOW-UP ACTIONS; BOFORS-NOBEL SITE

| Issue | Recommendation | Affects Protectiveness? (Y/N) | |
|---|---|---|---|
| | | Short-Term | Long-Term |
| Groundwater Containment by Extraction Wells | - Confirm / improve pumping efficiency; clean / maintain extraction wells<br>- Continue until TIC remedy containment effectiveness is known. | Y<br>N | N<br>Y |
| Groundwater Treatment in GWTP | - Continue until TIC remedy treatment component is assessed.<br>- Continue in the event TIC remedy treatment is not effective. | Y | Y |
| TIC Remedy (Barrier Wall) Design | - Complete Barrier Wall phase of TIC remedy design. | N | Y |
| Barrier Wall Construction | - Complete construction of Barrier Wall. | N | Y |
| TIC Remedy Design Completion (Other Components; Final Design) | - Complete design of Phytoremediation, Wetlands, Soil Cover, Monitoring programs, of TIC remedy. | N | Y |
| TIC Remedy Construction &Start-Up (Phytoremediation, Wetlands, Soil Cover, Monitoring) | - Complete construction and start-up of TIC remedy.<br>- Monitor TIC remedy for containment effectiveness. | N | Y |
| Groundwater Treatment by Wetland Technology | - Continue until remedy cleanup goals are reached. | N | Y |
| Measure Effectiveness of TIC Remedy (monitoring of all site remedies) | - Monitoring of TIC Remedy.<br>(continues until remedy cleanup goals are achieved) | Y | Y |
| O.U. #2 Record of Decision | - Issue O.U. #2 ROD based on performance of TIC remedy containment. | N | Y |
| Implementation of O.U. #2 ROD requirements. | - Design, construct, operate, maintain, any remedy required by an O.U. #2 ROD. | N | Y |
| Operation and maintenance of all site remedies. | - Operate, maintain, monitor site remedies before and after remedy cleanup goals are achieved. | N | Y |

## TABLE 3 - REDUCED SITE CONTAMINANT LIST: BOFORS-NOBEL SUPERFUND SITE

| CONTAMINANT SHOWN IN 1990 RI (Original Record of Decision) | CONTAMINANT TO REMAIN ON LIST FOR CONTINUED ANALYSIS * |
|---|---|
| Acenapthene | Acenapthene |
| Acenapthylene | |
| Acetone | Acetone |
| Alkyl benzene isomers | Alkyl benzene isomers |
| Aniline (cc) | Aniline (cc) |
| Anthracene | Anthracene |
| Azobenzene (cc) | Azobenzene (cc) |
| Azoxybenzene | Azoxybenzene |
| Benzene | Benzene |
| Benzeneacetic Acid | |
| Benzidine (cc) | Benzidine (cc) |
| Benzo(a)anthracene | Benzo(a)anthracene |
| Benzo(a)pyrene | |
| Benzothiazole isomer | |
| 1,2,3 - Benzothiadiazole | |
| Benzyl Alcohol | Benzyl Alcohol |
| Bis(2-ethylhexyl)phthalate | Bis(2-ethylhexyl)phthalate |
| Bromodichloromethane | |
| Bromoform | |
| Bromomethane | |
| 2-Butanone (MEK) | 2-Butanone (MEK) |
| Carbon Disulfide | Carbon Disulfide |
| Carbon Tetrachloride | |
| 2-Chloroaniline | 2-Chloroaniline |
| 4-Chloroaniline | 4-Chloroaniline |
| Chlorobenzene | Chlorobenzene |
| Chloroform | Chloroform |
| (3-Chlorophenyl) (4-Chlorophenyl) Methanone | (3-Chlorophenyl) (4-Chlorophenyl) Methanone |
| Chrysene | Chrysene |
| Dibenzofuran | |
| Dibromochloromethane | |
| Dichlorobromomethane | |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | 3,3'-Dichlorobenzidine (and isomers) (cc) |
| 1,2-Dichlorobenzene | 1,2-Dichlorobenzene |
| 1,1-Dichloroethane | |
| 1,2-Dichloroethane | 1,2-Dichloroethane |
| 1,1-Dichloroethene | 1,1-Dichloroethene |
| 1,2-Dichloroethene (and isomers) | 1,2-Dichloroethene (and isomers) |

* Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval. Monitoring for this contaminant may no longer be necessary.

** Compound is unknown in the sense that there were detections of organic chemicals but specific identification of a certain compound or isomer detected is unknown.

## TABLE 3 - REDUCED SITE CONTAMINANT LIST; BOFORS-NOBEL SUPERFUND SITE

| CONTAMINANT SHOWN IN 1990 RI (Original Record of Decision) | CONTAMINANT TO REMAIN ON LIST FOR CONTINUED ANALYSIS * |
|---|---|
| 1,2-Dichloropropane | |
| 1,3-Dichloropropene (& isomers) | |
| N,N - Dimethylformamide | N,N - Dimethylformamide |
| Dimethyl phthalate | Dimethyl phthalate |
| Dimethylbenzenamine | |
| Dimethylnapthalene | |
| Di-n-Butylphthalate | Di-n-Butylphthalate |
| Di-n-Octylphthalate | Di-n-Octylphthalate |
| 2,4-Dinitrophenol | |
| 1,1'-Diphenyl- 2,2-Diamine | 1,1'-Diphenyl- 2,2-Diamine |
| 2,3-Dihydrodimethyl-1H-Indene | |
| Ethylbenzene | Ethylbenzene |
| Fluoranthene | Fluoranthene |
| Fluorine | |
| 2-Hydroxybenzonitrile | |
| 4-hydroxy-4-methyl-2-pentanone | |
| Isophorone | Isophorone |
| 2-Methylnapthalane | 2-Methylnapthalane |
| 2-Methylphenol | 2-Methylphenol |
| 4-Methylphenol | 4-Methylphenol |
| 1-Methoxynitrobenzene | |
| 1-Methylnaphthalene | |
| 2-Methylnaphthalene | 2-Methylnaphthalene |
| Methoxybenzeneamine | |
| Methylene Chloride (cc) | Methylene Chloride (cc) |
| (Dichloromethane) | (Dichloromethane) |
| N-nitroso-Di-n-Propylamine | N-nitroso-Di-n-Propylamine |
| Napthalene | Napthalene |
| Nitrobenzene | Nitrobenzene |
| Phenanthrene | Phenanthrene |
| Phenol | Phenol |
| Pyrene | Pyrene |
| Sulfur | |
| 1,1' - Sulfonyl - bis (2-Methyl) Benzene | 1,1' - Sulfonyl - bis (2-Methyl) Benzene |
| Tetrachloroethylene | Tetrachloroethylene |
| 1,1,2,2-Tetrachloroethane | 1,1,2,2-Tetrachloroethane |
| Toluene (cc) | Toluene (cc) |
| 1,2,4-Trichlorobenzene | 1,2,4-Trichlorobenzene |

* Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval. Monitoring for this contaminant may no longer be necessary.

** Compound is unknown in the sense that there were detections of organic chemicals but specific identification of a certain compound or isomer detected is unknown.

**TABLE 4 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND. DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Acetone | 15000 | 42000 | 34000 | 7.40e+07 | ND [4] | 70 | | | | | | | | 91 | 11 |
| Alkyl benzene isomers [12] | N/L [5] | | | N/L [5] | ND [4] | | | 148000 J | | | 123000 J | | 147000 | 148000000 J | 4400 |
| Aniline (cc) | 3000 | 12000 | IP [9] | 4.50e+06 C [14] | ND [4] | 860 | | 9200 | | | | | 1700 | 3900000 | 3400 |
| Azobenzene (cc) | 1400 | 5900 | N/A [5] | 1.40e+06 | ND [4] | 93 J | | 12000000 | | 170000 | 680000 | 22000 J | 33000 J | 8200000 | 230000 |
| Azoxybenzene | N/L [5] | | | N/L [5] | ND [4] | | | 690000 J | | | | | | 36000 | 85000 |
| Benzene (cc) | 100 | 100 | 4000 X [13] | 400,000 C [14] | ND [4] | | | 980000 | | 23 | | | 2800 | 120000 | 8 J |
| Benzidine (cc) | 1000 M [11] | 1000 M [11] | ID [7] | 1,000 M [11] | ND [4] | | | 3400000 | | 2100 J | 70000 J | | 13000 | 1300000 | 13000 |
| 2-Butanone (MEK) | 260000 | 760000 | 44000 | 2.70e+07 C [14] | ND [4] | | | | | | | | | 25 J | |
| 2-Chloroaniline | N/L [5] | | | N/L [5] | ND [4] | 260000 | | 270000 | | 540 | 22000 J; 21000 | 240 | 12000 J | 2300000 | 24000 J |
| (3-Chlorophenyl) (4-Chlorophenyl) Methanone | N/L [5] | | | N/L [5] | ND [4] | 300000 J | | 6100000 J | | 330000 J | 1,300,000 | 520000 J | 34000 J | 6200000 | 190000 J |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | 2000 M [11] | 2000 M [11] | 2000 M [11], X [13] | 55000 | ND [4] | 65000 J | | 2700000 | | 930000; 950000 J | 390000; 1000000 J | 260000; 100000 J | 1500000; 1700000 J | 11,000,000 | 2900000; 3500000 J |
| Ethylbenzene | 1500 | 1500 | 360 | 140,000 C [14] | ND [4] | 51 | | | | | 9,200 | 1 | | | |
| Methylene Chloride (cc) | 100 | 100 | 19000 X [13] | 2.30e+06 C [14] | ND [4] | | | | | 4 J *** | 2200 J ** | 18 *** | 1200 J | | |
| Sulfur - NP [10] | N/L [5] | | | N/L [5] | ND [4] | 5100 J | | | | | | 8300 J | | 1500 | |

**TABLE 4 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1,1' - Sulfonyl - bis (2-Methyl) Benzene | N/L [5] | | | N/L [5] | ND [4] | | | | | | | | | | 82000 J |
| Tetrachloroethylene | 100 | 100 | 900 X [13] | 88000 C [14] | ND [4] | | | | | | | 82 | 680 | | |
| Toluene | 16000 | 16000 | 2800 | 250000 C [14] | ND [4] | 8,900 | | 1,100,000 | | 17 | 130,000 | | 80,000 | 1600000 | 210 |
| 1,2,4 - Trichlorobenzene | 4200 | 4200 | 1800 | 1.1e+06 C [14] | ND [4] | | | 350 | | 150 | 150 | | 7,100 | 250000 | |
| Unknowns **** [10] | | | | NP [10] | 26 J | | 1400 J | | | 5700 J | 503000 J | 19000 J | | | 14400 J |
| Xylenes (total) | 5600 | 5600 | 700 | 150,000 C [14] | ND [4] | 120 | | | | 14 | 58,000 | | | | |
| | | | | | | | | | | | | | | | |
| Aluminum | 1000 | 1000 | N/A [5] | 3.00e+08 | 3770000 | 250000 | 1110000 | 1740000 | 781000 | 7920000 | 4070000 | 1900000 | 6220000 | 1930000 | 3830000 |
| Antimony [10] | 4300 | 4300 | ID [7] | 1.60e+06 | ND [4] | 25200 | | | | | | | | | |
| Arsenic | 23000 | 23000 | 70000 X [13] | 100000 | ND [4] | 43800 E | 630 J | 6100 | 600 J | 3600 | 5100 | 780 J | 3700 J | 2700 J | 3300 J |
| Barium | 1.30e+06 | 1.30e+06 | 130000 [6] | 3.20e+08 | 12600 J | 9800 J | 5700 J | 40300 J | 3400 J | 48000 J | 43400 J | 18300 J | 85000 | 18300 J | 44700 J |
| Beryllium | 51000 | 51000 | G [13] | 2.30e+07 | ND [4] | | | 670 J | | 540 J | 2100 | 320 | | | 2400 |
| Cadmium | 6000 | 6000 | G,X [13] | 2.30e+06 | ND [4] | 424000 | | 21900 | | | | | | 15100 | |
| Calcium - NO [10] | | | G,X [13] | 4.5 e+06 | 109000 J | 83000 J | 242000 J | 64600000 | 676000J | 194000000 | 265000000 | 7350000 | 253000000 | 25900000 | 271000000 |
| Chromium | 30000 | 30000 | 3300 | 2.20e+07 | 2200 | 916000 | 2400 | 79500 | | 22100 | 12100 | 17000 | 68000 | 45700 | 21200 |
| Cobalt | 1000 | 2000 | 2000 | 2.30e+07 | 2200 J | 36700 | | | | 3500 J | 7700 J | | | | 3400 J |
| Copper | 1.60e+08 | 1.60e+08 | G [13] | 1.70e+08 | ND [4] | 1640000 | 41200 | 226000 | | 19100 | 14300 | 6400 | 2800 | 36700 | 27100 |
| Iron - NO [10] | 6000 | 6000 | N/A [5] | ID [7] | 2650000 | 5460000 | 2660000 | 11000000 | 1420000 | 3780000 | 2550000 | 3870000 | 2920000 | 13000000 | 1430000 |

**TABLE 4 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND. DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Lead | 1000 M [11] | 1000 M [11] | G,X [13] M [11] | 900,000 L [8] | 3200 | 6040000 E | **6200** | 887000 | 700 J | 34700 | 20800 | 37400 | 29700 R | 362000 | 12500 J |
| Magnesium - NO [10] | 8.40e+06 | 2.40e+07 | N/A [5] | 1.0e+09 D [6] | 342000 J | 95000 J | **368000 J** | 1840000 | 459000J | 2870000 | 2350000 | 721000 J | 3400000 | 3050000 | 2470000 |
| Manganese | 2000 M [11] | 2000 M [11] | G,X [13] | 2.10e+08 | 17300 | 2680000 | **41200** | 85200 | 23900 | 52000 | 46400 | 58600 | 71600 | 164000 | 32800 J |
| Mercury | 1700 | 1700 | 170 | 1.40e+06 | ND [4] | 150 E | **100** | 710 | | | | | | 330 | |
| Nickel | 100000 | 100000 | G [13] | 3.40e+08 | ND [4] | 460000 | **2100 J** | 21000 | | 17500 | 10300 J | 9300 | 3600 J | 15100 | 4800 J |
| Potassium - NO [10] | | | | NO [10] | **86400** | | **71800 J** | 189000 J | 106000 J | 412000 J | 245000 J | 79300 J | 394000 J R | 104000 J | 132000 J |
| Selenium | 4000 | 4000 | 400 | 2.30e+07 | ND [4] | | **680 J** | 3300 | | | | | | | 2400 J |
| Silver | 4500 | 13000 | 500 M [11] | 2.10e+07 | ND [4] | 15600 | | | | 4600 | | | | 1800 J | 1200 |
| Sodium [10] | 3.20e+06 | 9.00e+06 | N/A [5] | 1.0e+09 D [6] | ND [4] | | **26100 J** | 5920000 | 44000 J | 191000 J | 169000 J | 49900 J | 366000 J | 3500000 | 318000 J |
| Thallium | 2300 | 2300 | 4200 X [13] | 300000 | ND [4] | | | | | | | | | | |
| Vanadium | 1.00e+06 | 2.90e+06 | 240 | 3.90e+07 | 4800 | 28,600 | **3000 J** | 4200 J | 940 J | 17700 | 10800 J | 4600 J | 9300 J | 5400 J | 6200 J |
| Zinc | 2.40e+06 | 5.00e+06 | G [13] | 1.0e+09 D [6] | 1240000 | 59,400 | **15,900** | 91,200,000 | 18,500 | 1,240,000 | 1,280,000 | 8,370,000 | 2,510,000 | 61,800,000 | 1,270,000 |

**FOOTNOTES AND LEGEND FOR TABLE 4**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and February 1990 Remedial Investigation (RI) Report. Data represents maximum concentrations found in soils or sludge samples taken in lagoon area at an average depth of 10 feet deep. (Soil samples - 2 to 6 ft.; Sludge 10 to 12 ft.). No PCBS or pesticides (other than those shown) were detected. Blank spaces in Table 4 signify that compound was not detected in laboratory analysis. Values shown in format "1.0e+09" are scientific notation (i.e.,1.0e+09 = 1,000,000,000; 1.0e+06=1,000,000; 1.0e-03=0.001; 1.0 e-06=0.000001).

2 **IPGW** - Industrial Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future industrial land use scenario. **RPGW** - Residential Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future residential land use scenario. **GSIPGW** - Soil Cleanup Criteria Protective of GSI Criteria for Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for Big Black Creek. **DCV** - Direct Contact Value - Part 201 Industrial Direct Contact Value as of June 1999. This is the contaminant concentration in soil which, if exceeded, presents an unacceptable human risk by contact with the soil within a typical industrial scenario. Any exposure to lagoon area soil would be to an individual working on the Site within a controlled work environment. The DCV criterion is the basis for the O.U. #1 lagoon area cover component of the TIC remedy.

3 BACKGRD - Background concentration taken from sample in relatively "clean" site area.

4 ND - Compound Not Detected in laboratory analysis.

5 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria as of June 1999.
N/A - Not Available or Not Applicable, but contaminant has been listed as of June 1999.

6 D - Concentration constituting cleanup criteria exceeds 100 % in soil hence it is reduced to 100 %.

7 ID - Inadequate Data. There is not enough health risk data to develop criterion for this contaminant.

8 L - Criteria developed using the U.S. EPA integrated uptake Biokinetic Model for children. Higher level may be acceptable subject to U.S. EPA and State of Michigan review and approval procedure.

9 IP - Development of generic GSI value in process but not yet complete.

10 NP, NO - Contaminant discovered at the time of the 1990 ROD but subsequently shown (by subsequent sampling and analysis) as Not Present, Naturally Occurring, or well below soil, air, groundwater, or surface water cleanup criteria.

11 M - Method Detection Limit is cleanup criterion. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect then the MDL becomes the cleanup standard.

12 Alkylbenzene isomers are compounds related to Toluene, Ethylbenzene, and Isopropylbenzene (all are "Alkyl benzenes").

13 G - Soil criteria for GSI protection is dependent on hardness of water in the area. X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 C - Soil criteria is based on contaminant-specific generic soil saturation concentration to insure a more protective cleanup goal. Soil criterion may be modified based on an acceptable site-specific demonstration subject to U.S. EPA/MDEQ review and approval.

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers noted as letters next to numerical values. Explanations of these qualifiers are as follows:

** Not found in duplicate analysis; *** Less than 10 times the concentration found in lab field or background blanks; **** Compound is unknown in the sense that there were detections of organic chemicals but specific identification of a certain compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory carried with field samples transported and stored. If contamination is found in a blank there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling storage transportation or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

**TABLE 5 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Acenapthene | 3,800 | 1,300 | 19 | 4200 S [7] | ND[9] | 20 |
| Acenapthylene [17] | 75 | 26 | ID[12] | 3900 S [7] | ND | 21 |
| Acetone | 2,100 | 730 | 1,700 | 31,000,000 | ND | 5,100; 81,000 E |
| Aniline (cc) | 610 | 150 | IP [14] | 370,000 | ND | 10,000 |
| Anthracene | 43 S [7] | 43 S [7] | ID [12] | 43 S [7] | ND | 14 J |
| Azobenzene (cc) | 32 | 7.7 | NA [5] | 410 | ND | 420 @ PW-40 (7/93) |
| Benzene (cc) | 5 A [8] | 5 A [8] | 200 X[13] | 9,400 | 8,000 | 65 000 |
| Benzeneacetic acid [17] | N/L [11] | NOT LISTED | | | ND | 140 J |
| Benzidine (cc) | 0.3 M [10] | 0.3 M [10] | ID [12] | 6.8 | ND | 12,000 @ MW-106 (6/92) |
| Benzo(a)anthracene | 5 M [10] | 5 M [10] | NA [5] | 5 M [10] | ND | 19 J |
| Benzo(a)pyrene [17] | 5 M [10] | 5 M [10] | ID[12] | 5 M [10] | ND | 230 |
| 1,2,3-Benzothiadiazole [17] | N/L [11] | NOT LISTED | | | ND | 1,300 J |
| Benzyl Alcohol | 29,000 | 10,000 | NA [5] | 44,000,000 S[7] | ND | 310 @ PW-39 (6/92) |
| Bis(2-ethylhexyl)phthalate | 6 A [8] | 6 A [8] | 32 | 47 | ND | 4,000 J |
| Carbon Disulfide | 2,300 | 800 | ID [12] | 1,100,000 | ND | 1,000 |
| 2-Chloroaniline | N/L [11] | NOT LISTED | | | ND | 63,000 |
| 4-Chloroaniline | N/L [11] | NOT LISTED | | | ND | 62 @ MW-62 (7/93) |
| Chlorobenzene | 100 A [8] | 100 A [8] | 47 | 68,000 | ND | 920 |
| Chloroform | 100 A,W [8,15] | 100 A,W [8,15] | 170 X[13] | 96,000 | ND | 4.8 @ MW-60 (6/94) |

**TABLE 5 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| (3-chlorophenyl)(4-chlorophenyl) - methanone | N/L [11] | NOT LISTED | | | ND | 700 J |
| Chrysene | 5 M [10] | 5 M [10] | ID [12] | 5 M [10] | ND | 19 J |
| Dibenzofuran [17] | ID [12] | ID [12] | 4 | ID [12] | ND | 18 J |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | 7.7 | 1.9 | 0.3 M,X [10,13] | 270 | ND | 2,600 |
| 1,2-Dichlorobenzene | 600 A [8] | 600 A [8] | 16 | 160,000 S [7] | ND | 400 |
| 1,2-Dichloroethane | 5 A [8] | 5 A [8] | 360 X [13] | 11,000 | ND | 110 |
| 1,1-Dichloroethylene (ethene) | 7 A [8] | 7 A [8] | 65 X [13] | 9000 | ND | 34 J @ PW-33 (6/94) |
| 1,2-Dichloroethylene (ethene) | 70 A [8] | 70 A [8] | ID [12] | 170,000 | ND | 2,400 @ PW-33 (6/94) |
| N,N - Dimethylformamide | 2,000 | 700 | NA [5] | 130,000,000 | ND | 450 J |
| Dimethyl phthalate | 210,000 | 73,000 | NA [5] | 4,200,000 S [7] | ND | 120 J |
| Dimethylbenzenamine [17] | N/L [11] | NOT LISTED | | | ND | 780 J |
| Dimethylnapthalene [17] | N/L [11] | NOT LISTED | | | ND | 52 J |
| Di-n-Butylphthalate | 2,500 | 880 | 9.7 | 11,000 S [7] | ND | 180 @ PW-40 (11/93) |
| Di-n-Octylphthalate | 380 | 130 | ID [12] | 250 | ND | 459 @ PW-40 (6/92) |
| 1,1'-Diphenyl- 2,2-Diamine | N/L [11] | NOT LISTED | | | ND | 3,200 J |
| 2,3-Dihydrodimethyl-1H-Indene | N/L [11] | NOT LISTED | | | ND | 42 J |
| Ethylbenzene | 74 E [14] | 74 E [14] | 18 | 170,000 S [7] | ND | 340 @ PW-41 (9/92) |

**TABLE 5 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Fluoranthene | 210 S [7] | 210 S[7] | 1.6 | 210 S [7] | ND | 16 J |
| Fluorine [17] | 2,000 A E [8] | 2,000 A E [8] | NA [5] | 13,000,000 | ND | 16 J |
| 2-Hydroxybenzonitrile [17] | N/L [11] | NOT LISTED | | | ND | 44 J |
| 4-hydroxy-4-methyl-2-pentanone[17] | N/L [11] | NOT LISTED | | | ND | 190 J |
| Isophorone | 3,700 | 900 | 570 X [13] | 1,100,000 | ND | 1,400 |
| 2-Methylnapthalane | 750 | 260 | ID [12] | 32,000 | ND | 480 |
| 2-Methylphenol | 1,000 | 370 | 82 | 710,000 | ND | 470 |
| 4-Methylphenol | 100 | 37 | ID [12] | 75,000 | ND | 170 |
| 1-Methoxynitrobenzene [17] | N/L [11] | NOT LISTED | | | ND | 22,000 J |
| 1-Methylnaphthalene [17] | N/L [11] | NOT LISTED | | | ND | 490 J |
| Methoxybenzeneamine [17] | N/L [11] | NOT LISTED | | | ND | 21,000 J |
| Methylene Chloride | 5 A [8] | 5 A [8] | 940 X[13] | 110,000 | ND | 5,820 @ PW-38 (6/92) |
| N-nitroso-Di-n-Propylamine | 5 M [10] | 5 M [10] | NA [5] | 220 | ND | 30 @ PW-34 (12/92) |
| Naphthalene | 750 | 260 | 13 | 31,000 S [7] | ND | 650 |
| Nitrobenzene | 9.6 | 5 M [10] | 180 X [13] | 9,600 | ND | 6,600 |
| Phenanthrene | 75 | 26 | 5 M [10] | 1,000 S [7] | ND | 19 J |
| Phenol | 13,000 | 4,400 | 210 | 28,000,000 | ND | 140; 170 J |
| Pyrene | 140 S [7] | 140 S [7] | ID [12] | 140 S [7] | ND | 27 |
| Sulfur [17] | N/L [11] | NOT LISTED | | | ND | 1,800 J |

**TABLE 5 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Tetrachloroethylene | 5 A [8] | 5 A [8] | 45 X[13] | 5,100 | ND | 18,000 |
| Toluene | 790 E [8] | 790 E [8] | 140 | 530,000 S [7] | 3,000 J | 280,000 |
| 1,2,4-Trichlorobenzene | 70 A[8] | 70 A[8] | 30 | 15,000 | ND | 56 J |
| Trichloro-1-propene isomer [17] | N/L [11] | NOT LISTED | | | ND | 36 J |
| Trichloroethylene | 5 A [8] | 5 A [8] | 200 X[13] | 11,000 | ND | 2,100 @ F V-33 (6/94) |
| 3,3,5-Trimethylcyclohexanone | N/L [11] | NOT LISTED | | | ND | 31,000 J |
| Trimp (trimethylphenols) | N/L [11] | NOT LISTED | | | ND | 2,000 J |
| 1,2,4-Trithiolane [17] | N/L [11] | NOT LISTED | | | ND | 420 J |
| 1,3,5-Trithlane [17] | N/L [11] | NOT LISTED | | | ND | 100 J |
| Unknowns **** | N/L [11] | NOT LISTED | | | ND | 100,500 |
| Vinyl chloride | 2 A [8] | 2 A [8] | 15 | 290 | ND | 1,000 |
| Xylenes (total) | 280 E [8] | 280 E [8] | 35 | 190,000 S [7] | 8,000 | 580 @ PW-41 (5/91) |
| Aluminum | 50 | 50 | NA [5] | 70,000,000 | 192 | 23,200 |
| Antimony [17] | 6 A [8] | 6 A [8] | ID [12] | 75,000 | 61.3 | 61 |
| Arsenic | 50 A [8] | 50 A [8] | 150 X [13] | 4,700 | 4.8 J | 74 |
| Barium | 2,000 A [8] | 2,000 A [8] | 190 | 15,000,000 | 23.2 J | 174 J |
| Beryllium | 4 A [8] | 4 A [8] | G [18] | 1,100,000 | ND | 14 @ MW-72 (12/92) |
| Cadmium | 5 A [8] | 5 A [8] | G[18], X[13] | 210,000 | 5.3 | 120,000 @ IL-01 (3/93) |

**TABLE 5 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Calcium [17] | (no threat to human health and the environment) | | | | 43,700 | 345,800 @ PW-41 (10/91) |
| Chromium (VI) | 100 A [8] | 100 A [8] | 11 | 1,000,000 | 28.2 | 74 @ MW-72 (12/92) |
| Cobalt | 100 | 50 M [10] | 100 | 1,100,000 | 10 | 38 @ MW-72 (12/92) |
| Copper | 1,000 E [8] | 1,000 E [8] | G[18] | 8,100,000 | 64.7 | 120 @ MW-72 (12/92) |
| Iron [17] | 300 E [8] | 300 E [8] | NA [5] | ID [12] | 768 | 35,400 |
| Lead | 4 L [19] | 4 L [19] | G,X [13,18] | ID [12] | 7.3 | 8,800 @ MW-110 (9/92) |
| Magnesium [17] | 1,200,000 | 420,000 | NA [5] | 1,000,000,000 D[20] | 13,200 | 85,000 @ MW-106 (9/92) |
| Manganese | 50 E [8] | 50 E [8] | G,X [13,18] | 10,000,000 | 34 | 5,390 |
| Mercury | 2 A [8] | 2 A [8] | 0.2 M [15] | 56 S[7] | 0.2 | 1.3 |
| Nickel [17] | 100 A [8] | 100 A [8] | G[18] | 16,000,000 | 22.9 J | 810 @ MW-110 (9/92) |
| Potassium [17] | (no threat to human health and the environment) | | | | 1930 J | 16,500 |
| Selenium | 50 A [8] | 50 A [8] | 5 | 1,100,000 | 3.6 J | 14.7 |
| Silver | 98 | 34 | 0.2 M [15] | 1,000,000 | 12.9 | 16,000 @ MW-72 (12/92) |
| Sodium [17] | 450,000 | 160,000 | NA [5] | 1,000,000,000 D[20] | 1430 | 1,610,000 |
| Thallium | 2 A [8] | 2 A [8] | 3.7 X [13] | 14,000 | ND | 30 @ MW-110 (9/92) |
| Vanadium | 180 | 64 | 12 | 1,900,000 | 12.7 J | 412 |
| Zinc | 5,000 E [8] | 2,400 | G[18] | 70,000,000 | 88.7 | 210,000 @ MW-72 (12/92) |

**FOOTNOTES AND LEGEND FOR TABLE 5**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and Landfill Remedy Remedial Design. Maximums represent either the maximum shown in the ROD, or the maximum concentration discovered during RD quarterly groundwater monitoring from mid-1992 to mid-1994. Maximum concentrations that have been noted with location and (month/year) are 1991-94 RD data. All other maximums are 1990 ROD and RI data.

2 Industrial Drinking Water Standard is the cleanup criteria that are applicable to groundwater unless appropriate deed restrictions can not be obtained for future industrial land use, in which case criteria for future residential land use would apply for groundwater.

3 Residential Drinking Water Standard is the cleanup criteria that are applicable to groundwater for future residential land use.

4 Groundwater - Surface Water Interface (GSI) Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of a surface water body that receives such contaminated groundwater discharge. These GSI limits must be maintained to insure protection of Big Black Creek.

5 Groundwater Contact Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of human health in the event of inadvertent human direct contact with such contaminated groundwater.

6 BACKGROUND - Background concentration taken from sample in relatively "clean" Site area as shown in the February 1990 Remedial Investigation (RI) report. For cleanup standards noted by a 'B', background concentrations may be used instead of the value shown.

7 S - Criterion is based on the chemical specific water solubility limit.

8 A - State of Michigan Drinking Water Criterion established pursuant to Section 5 of the Safe Drinking Water Act, Act No. 399 of the Public Acts of 1976;
E - Criterion is the aesthetic drinking water value, as required by Sec. 20120(1)(5).

9 ND - Compound Not Detected in laboratory analysis.

10 M - Criterion is below the Method Detection Limit, therefore, the criterion defaults to the MDL. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect, then the MDL becomes the cleanup criterion.

11 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria.

12 ID - Inadequate Data. The State of Michigan does not have enough health risk data to develop criterion for this contaminant.

13 X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 IP - Development of generic GSI value in process but not yet complete.

15 W - Concentrations of trihalomethanes in groundwater must be added together to determine compliance with the Drinking Water Standard of 100 ppb.

16 NA - Not Available.

17 Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by subsequent sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval.

18 H - Standard is dependent on "hardness" of groundwater; G - GSI cleanup criterion is dependent upon water hardness in the area.

19 L - For Lead, higher concentrations may be acceptable and criteria may be modified based on an acceptable site-specific demonstration subject to U.S. EPA/MDEQ review and approval.

20 D - Calculated groundwater criterion exceeds 100 % and is reduced to 100 %. Site - specific evaluation of contaminant status and adverse impacts subject to U.S. EPA/MDEQ review and approval may be required.

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA, limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers, noted as letters next to numerical values. Explanations of these qualifiers are as follows:

**** Compound is noted as "unknown" because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory, carried with field samples, transported, and stored. If contamination is found in a blank, there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling, storage, transportation, or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

## TABLE 6 - COMPARISON [1] OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[3] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[3] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Aniline (cc) | Groundwater | 10,000 ppb (WC-27) | 780 D ppb (PW-34) | 100 ppb (W-1; MW-43) |
| | Soil/Sludge | 3,900 ppm (L-9) | N/A[8] | < 310 U ppm (L-9) |
| Azobenzene (cc) | Groundwater | 20 J ppb (PW-41) | ND [5] | N/A[8] |
| | Soil/Sludge | 12,000 ppm (L-3) | N/A[8] | N/A[8] |
| Benzene | Groundwater | 65,000 ppb (WC-27) | 9400 ppb (PW-34) | 39,000 ppb (W-1; MW-43) [6] |
| | Soil/Sludge | 980 ppm (L-3) | N/A[8] | 84 ppm (L-9) |
| Benzidine (cc) | Groundwater | 1300 ppb (MW-108) | 1600 D ppb (MW-60) | 110 ppb (P-108 D) |
| | Soil/Sludge | 3,400 ppm (L-3) | N/A[8] | < 950 U ppm (L-9) |
| Benzyl Alcohol | Groundwater | 5 J ppb (LW-3) | ND [5] | N/A |
| Footnote (7) | Soil/Sludge | ND [5] | N/A[8] | N/A |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | Groundwater | 1,900 ppb (WC-27); 2,600 ppb (PW-41) | 280 D ppb (PW-34) | < 200 U ppb MW-43<br>47 ppb (MW-110)<br>46 ppb (OW-108) |
| | Soil/Sludge | 11,000 ppm (L-9) | N/A[8] | 4,900 ppm (L-9) |
| 1,2-Dichloroethene (and isomers) | Groundwater | 1,900 ppb (LW-3) | 2,400 (PW-33) | < 1,000 U ppb (MW-43)<br>< 2 UJ ppb (MW-110) |
| | Soil/Sludge | ND [5] | N/A[8] | N/A |
| Ethylbenzene | Groundwater | 3 J ppb (MW-110) | 120 ppb (PW-41) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 9.2 ppm (L-6) | N/A[8] | < 24 U ppm (L-9) |
| Methylene Chloride (cc) (Dichloromethane) | Groundwater | 1400 J ppb (WC-2) | 5.2 J ppb (PW-41) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 2.2 ppm (L-6) | N/A[8] | < 24 U ppm (L-9) |
| Toluene (cc) | Groundwater | 280,000 ppb (WC-27) | 2,900 ppb (PW-39) | 10,000 ppb (MW-43) |
| | Soil/Sludge | 1,600 ppm (L-9) | N/A[8] | 770 ppm (L-9) |
| Vinyl Chloride | Groundwater | 1,000 ppb (PW-33) | 760 ppb (PW-33) | < 1 UJ ppb (MW-110; 55') |
| | Soil/Sludge | ND [5] | N/A[8] | < 24 U ppm (L-9) |
| Xylenes (total) | Groundwater | 100 ppb (PW-41) | 50 ppb (PW-41) | < 3 UJ ppb (P-108; 60')<br>< 1500 U ppb (MW-43) |
| | Soil/Sludge | 58 ppm (L-6) | N/A[8] | < 71 U ppm (L-9) |

**FOOTNOTES AND LEGEND FOR TABLE 6**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 This is a "limited" comparison because there are more contaminants known to still be present at various locations and concentrations throughout the site. Some contaminants shown here remain at concentrations above site cleanup goals. Data taken from Record of Decision and February 1990 Remedial Investigation (RI) Report. To convert ppb to ppm, divide by 1000 and vice versa (ppm to ppb, multiply by 1000).

2 See Figure 4 - Site Layout and Sampling Locations.

3 Data taken from 7th quarter (June 1994) of quarterly groundwater monitoring performed by USACE for Remedial Design of Landfill Remedy. Although analysis for inorganic contaminants was discontinued after Quarter 4 of the RD monitoring program, maximums prior to June 1994 are noted with (month/year).

4 Data taken from document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site", dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record.

5 ND - Compound Not Detected in laboratory analysis.

6 Sampling location W-1 is in close proximity to monitoring well that was labeled MW-43 for sampling performed for the February 1990 Remedial Investigation (RI) Report.

7 Contaminant will be monitored and, because there is no GSI standard, must either be below laboratory detection limits (ND), or, must be demonstrated as not posing any threat to human health and the environment. This demonstration may include toxicity testing as required.

8 N/A - Not analyzed. There was no chemical analyses performed on lagoon area soil or sludge during the Landfill Remedy Remedial Design.

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA, limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers, noted as letters next to numerical values. Explanations of these qualifiers are as follows:

**** Compound is noted as "unknown" because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

U - Contract Required Quantitation Limit - This signifies that the value shown with a "U" was the lowest reproducible limit that the laboratory equipment could detect.

D- Diluted sample

## TABLE 7 - REDUCTION [1] IN CONTAMINANT CONCENTRATIONS; GROUNDWATER; BOFORS-NOBEL SITE

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | CONTAMINANT LEVEL FROM 1989-90 RI, ROD[3] (ppb) | SAMPLE LOCATION IN CONTAMINATED AREA | INTERMEDIATE RESULT [4] (Year; ppb) | DEC. 2002 RESULT [4] (ppb) |
|---|---|---|---|---|---|
| Aniline (cc) | 610 | 10,000 (@WC-27) | PW-34 | 1991; 570 | 420 |
| Azobenzene (cc) | 32 | 20 | PW-40 | 1993; 420 | < 5 |
| Benzene (cc) | 5 | 65,000 | PW-34 | 1994; 9400 | 4500 |
| Benzidine (cc) | 0.3 | 910 (@ PW-39) | PW-39 | 1991; 300 | 150 |
| Benzidine (and isomer) (cc) | | 48,000 (Year 1987) | MW-60 (Cluster) | 1993; 2600 | 400 |
| Benzyl Alcohol | 29,000 | 5 | PW-39 | 1992; 310 | < 50 |
| 3,3'-Dichlorobenzidine (cc) | 7.7 | 2600 (@ PW-41) | PW-41 | 1992; 533 | 190 |
| 1,2-Dichloroethylene (ethene) | 70 | 180 (@PW-41) | PW-41 | 1991; 300 | 70 |
| Ethylbenzene | 74 | 500 (@PW-32) | PW-41 | 1992; 340 | 20 |
| Methylene Chloride | 5 | 1100 (@ PW-41) | PW-38 | 1992; 5820 | < 5 |
| Toluene | 790 | 280000 (@ WC-27) | PW-38 | 1992; 7350 | 5800 |
| Vinyl chloride | 2 | 530 (@PW-33) | PW-30 | 1997; 400 | 240 |
| Xylenes (total) | 280 | 100 (@PW-41) | PW-41 | 1993; 470 | 13 |

**FOOTNOTES FOR TABLE 7**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk.

[1] This is a "limited" analysis because there are more contaminants known to still be present at various locations and concentrations throughout the site; some contaminants shown here remain at concentrations above site cleanup goals.

[2] Industrial Drinking Water Standard is the cleanup criteria that are applicable to groundwater unless appropriate deed restrictions can not be obtained for future industrial land use, in which case criteria for future residential land use would apply for groundwater.

[3] Approximate locations are shown in Figure 4.

[4] At "sample location in contaminated area".

**TABLE 8 - EFFECTIVENESS OF GWTP OPERATION; BOFORS-NOBEL SITE**

| CONTAMINANT | HIGHEST GROUNDWATER CONTAMINANT LEVEL RECORDED [1] (ppb) | HIGHEST CONTAMINANT CONCENTRATION INTO GWTP [2] (ppb) | CURRENT CONTAMINANT INTO GWTP (Apr. 2003) (ppb) | GWTP DISCHARGE PERMIT LIMIT (ppb) | CONTAMINANT DISCHARGED OUT OF GWTP (ppb) |
|---|---|---|---|---|---|
| Aniline (cc) | 10000 | 140 | < 5 | < 5 | < 5 |
| Azobenzene (cc) | 420 | 5 | < 5 | N/A | < 5 |
| Benzene (cc) | 65000 | 1200 | 1200 | REPORT | < 1 |
| Benzidine (cc) | 12000 | 270 | < 0.12 | < 0.12 | < 0.12 |
| 3,3'-Dichlorobenzidine (cc) | 2600 | 160 | < 0.18 | < 0.18 | < 0.18 |
| 1,2-Dichloroethylene (ethene) | 2400 | 110 | < 5 | < 1 | < 1 |
| Ethylbenzene | 340 | 17 | < 5 | N/A | < 1 |
| Methylene Chloride | 5820 | < 5 | < 5 | N/A | < 5 |
| Toluene | 280000 | 1300 | 1300 | 1600 | < 1 |
| Vinyl chloride | 1000 | 15 | < 5 | N/A | < 1 |
| Xylenes (total) | 580 | 18 | < 5 | N/A | < 1 |

**FOOTNOTES FOR TABLE 8**

[1] Data obtained from either: RI/FS (1988-91), RODs or ROD amendments, RD/RA activity (1992-94, 1997), or Interim Monitoring (1999-2002).

[2] GWTP data taken from monthly operating reports since 1994.

N/A This contaminant has shown not to be a problem in the GWTP discharge, and therefore does not need to be reported.

REPORT Permit requires only that this contaminant be reported if it shows up as "present" (i.e. it has been demonstrated that this contaminant is effectively removed under normal circumstances).

**TABLE 9 - CAPITAL COSTS REQUIRED FOR TIC REMEDY [1]; 1999 ROD AMENDMENT; O.U. #1; BOFORS-NOBEL SITE**

| PROJECT ACTIVITY | QUANTITY | UNIT COST | COST |
|---|---|---|---|
| Lagoon Area surface cleanup and earthwork [2] | 15 acres * | $ 16,118 / acre | $ 241,770 |
| Lagoon Area Cap construction (including seeding, mulching, etc.) [3] | 15 acres * | $ 33,306 / acre | $ 499,590 |
| Planting of vegetation (Areas A,B,C,D, including fertilizer) [4] | 17 acres * | $ 68,000 / acre | $ 1,156,000 |
| Monitoring (start-up) of installed vegetation (1st 5 years) including replacement (if needed) | 20 acres * | $ 26,750 / acre | $ 535,000 |
| Barrier Wall installation [5] | 2700 feet | $ 1,175 / foot | $ 3,172,500 |
| Groundwater Extraction System [6] | Lump Sum | | $ 798,480 |
| Constructed Wetland [7] | Lump Sum | | $ 508,650 |
| Retrofit existing GWTP for TIC Remedy [8] | Lump Sum | | $ 395,000 |
| Replacement GWTP (after 5 years) [9] | Lump Sum | | $ 675,000 |
| Installation of Monitoring Wells [10] | 30 wells | $ 5,667 each | $ 170,000 |
| SUBTOTAL | | | $ 8,151,990 |
| Cost Estimate Contingency (25 %) | | | $ 2,038,000 |
| MINIMUM CONSTRUCTION CAPITAL FUNDING | | | $10,189,990 |
| Contingent Action - Upgrade of cap impermeability [11] | 15 acres | $ 94,600 / acre | $ 1,419,000 |
| Contingent Action - Maint. and/or Repair of Const. Wetland [12] | Lump Sum | | $ 793,770 |
| Contingent Action - Restore/enhance installed vegetation [13] | Lump Sum | | $ 621,840 |
| Contingent Action - Additional Barrier Wall (including design) | Lump Sum | | $ 723,520 |
| Contingent Action - Install 10 New Extraction Wells in addition to Barrier Wall | 10 wells<br>500 ft. piping | $10,000 each<br>$ 35/ft pipe | $ 117,500 |
| SUBTOTAL OF CONTINGENT ACTIONS | | | $ 3,675,630 |
| Cost Estimate Contingency (25 %) | | | $ 918,910 |
| ADDITIONAL CONSTRUCTION CAPITAL FUNDING REQUIRED FOR CONTINGENT ACTIONS | | | $ 4,594,540 |
| TOTAL CONSTRUCTION CAPITAL INCLUDING CONTINGENT ACTIONS | | | $ 14,784,530 |
| REMEDIAL DESIGN (RD) COST FOR TIC REMEDY [14] | | | $ 5,450,000 |
| MINIMUM CONSTRUCTION CAPITAL | | | $ 10,189,990 |
| TOTAL MINIMUM PROJECT COST | | | $ 15,639,990 |

**FOOTNOTES FOR TABLE 9**

* Actual lagoon and sludge surficial area totals approximately 15 acres (see Figure 3). A value of 17 acres is estimated for planted vegetation to include 2 additional acres for integration of vegetation into natural vegetation existing at the lagoon periphery. An allowance of 20 acres is used for monitoring and includes 5 acres as contingency.

1 All values shown are approximate and were included for ROD Amendment purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site" dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. Cost estimates are being refined during the RD.

2 Table 8-4 of 9/9/97 Tech Memo - Items 1 through 9.

3 Table 8-4 of 9/9/97 Tech Memo - Items 10 through 17, including an allowance for field work completion document.

4 Table 8-5 of 9/9/97 Tech Memo - Items 1 through 12, including dust control during construction. Areas A, B, C, and D are designations that represent different vegetative species, with Area A containing the highest concentrations of contaminants.

5 Table 8-6 of 9/9/97 Tech Memo - Items 1 through 14.

6 Table 8-8 of 9/9/97 Tech Memo - Items 1 - 13. This task entails retrofit of existing extraction well system and construction of collection, extraction, discharge point in concert with barrier wall (such as control weir and/or valving).

7 Table 8-7 of 9/9/97 Tech Memo - Items 1 through 17.

8 Table 8-9 of 9/9/97 Tech Memo - Items 1 and 2. This task entails consideration of using a portion of the already operating GWTP and/or retrofit, if feasible.

9 Table 8-11 B of 9/9/97 Tech Memo. This is the possible GWTP replacement with a smaller, alternative GWTP and lower extraction rates created by the barrier wall. Cost shown is discounted value to Year 2002.

10 Table 8-10 - Item 1, and Table 8-11A - Items 1 through 3 of 9/9/97 Tech Memo. Capital allowance represents a one-time monitoring well installation capital cost for both measurement of barrier wall effectiveness and potential natural attenuation. Short- and Long-Term Monitoring costs are included in Table 9, which summarizes annual costs for operation and maintenance and monitoring.

11 Table 8-4 of 9/9/97 Tech Memo.

12 Table 8-7 of 9/9/97 Tech Memo.

13 Table 8-5 of 9/9/97 Tech Memo. Nutrients, installation of 'tube' protection through highest contamination layer, and supplemental Zone A re-planting included in this contingent task.

14 Tables 8-10 and 8-13 of 9/9/97 Tech Memo. Includes all costs for RD sampling and analysis activity including all quality assurance and work plans.

**TABLE 10 - "TIME WEIGHTED" AVERAGE ANNUAL COST OF MONITORING & O&M OF TIC REMEDY; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| ITEM | PROJECT ACTIVITY[1] | ANNUAL COST[2] | YEARS FROM - TO | TIME PERIOD (YRS.) | FRACTION OF PROJECT TIME | "WEIGHTED" ANNUAL COST |
|---|---|---|---|---|---|---|
| a. | GW Monitoring During RD/RA | $ 80,000 | 1999 - 2002 | 3 | 3 ÷ 103 = 0.029 | $ 2,320 |
| b. | Post-const. GW Mon | $ 70,000 | 2002 - 2007 | 5 | 5 ÷ 103 = 0.049 | $ 3,430 |
| c. | LTGW Monitoring | $ 70,000 | 2007 - 2032 | 25 | 25 ÷ 103 = 0.243 | $ 17,010 |
| d | LTGW Monitoring | $ 50,000 | 2032 - 2102 | 70 | 70 ÷ 103 = 0.680 | $ 34,000 |
| TOTAL TIME | | | 103 | "TIME WEIGHTED" ANNUAL COST OF MONITORING[3] | | $ 56,760 |
| e. | Existing GWTP Oper. | $ 600,000 | 1999 - 2002 | 3 | 0.029 | $ 17,400 |
| f. | Existing Well Oper. | $ 150,000 | 1999 - 2002 | 3 | 0.029 | $ 4,350 |
| g. | Existing GWTP Oper. | $ 400,000 | 2002 - 2007 | 5 | 0.049 | $ 19,600 |
| h. | Existing Well Oper. | $ 100,000 | 2002 - 2007 | 5 | 0.049 | $ 4,900 |
| I. | Initial Site Mgmt. | $ 200,000 | 2002 - 2007 | 5 | 0.049 | $ 9,800 |
| j. | O&M of New Alt. GWTP | $ 400,000 | 2007 - 2032 | 25 | 0.243 | $ 97,200 |
| k. | Post-const. Site Mgmt. | $ 100,000 | 2007 - 2032 | 25 | 0.243 | $ 24,300 |
| l | O&M of New Alt. GWTP (inc. Samp./Analysis) | $ 253,000 | 2032 - 2102 | 70 | 0.680 | $ 172,040 |
| m. | Long Term Site Mgmt . | $ 50,000 | 2032 - 2102 | 70 | 0.680 | $ 34,000 |
| "TIME WEIGHTED" ANNUAL O&M COST[3] | | | | | | $ 383,590 |

**FOOTNOTES FOR TABLE 10**

1,2 As identified in Table 11. All values shown are approximate and are included for ROD Amendment purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site", dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. These cost estimates will be further refined within the Remedial Design.

3 "Time weighted" annual costs do not represent higher O&M costs during initial remedy operation because of the variance in annual O&M costs and time periods. A decrease in the total project time period will increase the "time weighted" values shown.

**TABLE 11 - PRESENT WORTH OF O&M AND MONITORING COSTS[1] FOR TIC REMEDY**
**1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE**

| ITEM | PROJECT ACTIVITY | ANNUAL COST[2] | PROJECT YEAR FROM - TO | YEARS AWAY FROM 1999 | P/F FACTOR[3] (@ 5%) | ANNUAL COST DISCOUNTED TO YEAR 1999 | TIME PERIOD IN YEARS | P/A FACTOR[3] (@ 5%) | PRESENT WORTH IN 1999 DOLLARS[4] |
|---|---|---|---|---|---|---|---|---|---|
| a. | Groundwater Monitoring During RD/RA Activity (1st 2 years, quarterly) [5] | $ 80,000 | 1999 - 2002 | 0 | 1.0 | $ 80,000 | 3 | 2.722 | $ 217,760 |
| b. | Post-construction Groundwater Monitoring [6] | $ 70,000 | 2002 - 2007 | 3 | 0.864 | $ 60,480 | 5 | 4.331 | $ 261,940 |
| c. | Long Term Groundwater Monitoring | $ 70,000 | 2007 - 2032 | 8 | 0.677 | $ 47,390 | 25 | 14.096 | $ 668,010 |
| d. | Long Term Groundwater Monitoring [7] | $ 50,000 | 2032 - 2102 | 33 | 0.200 | $ 10,000 | 70 | 19.343 | $ 193,430 |
| e. | Operation of Existing GWTP [8] | $ 600,000 | 1999 - 2002 | 0 | 1.0 | $ 600,000 | 3 | 2.722 | $ 1,633,200 |
| f. | Operation of Existing Extraction Well Field [9] | $ 150,000 | 1999 - 2002 | 0 | 1.0 | $ 150,000 | 3 | 2.722 | $ 408,300 |
| g. | Operation of Existing GWTP [10] | $ 400,000 | 2002 - 2007 | 3 | 0.864 | $ 345,600 | 5 | 4.331 | $ 1,496,800 |
| h. | Operation of Existing Extraction Well Field [11] | $ 100,000 | 2002 - 2007 | 3 | 0.864 | $ 86,400 | 5 | 4.331 | $ 374,200 |
| I. | Initial Lagoon and GWTP Site Management [12] | $ 200,000 | 2002 - 2007 | 3 | 0.864 | $ 172,800 | 5 | 4.331 | $ 748,400 |
| j. | O&M of New Alternative GWTP [13] | $ 400,000 | 2007 - 2032 | 8 | 0.677 | $ 270,800 | 25 | 14.096 | $ 3,817,200 |
| k. | Post-construction Lagoon Area Site Management [14] | $ 100,000 | 2007 - 2032 | 8 | 0.677 | $ 67,700 | 25 | 14.096 | $ 954,300 |
| l. | O&M of New Alternative GWTP (includes sampling and analysis needed for GWTP operation) | $ 253,000 | 2032 - 2102 | 33 | 0.200 | $ 50,600 | 70 | 19.343 | $ 978,760 |
| m | Long Term Lagoon Area Site Management [15] | $ 50,000 | 2032 - 2102 | 33 | 0.200 | $ 10,000 | 70 | 19.343 | $ 193,430 |
| | SUBTOTAL | | | | | | | | $11,945,730 |
| n. | Cost Estimate Contingency (25 %) | | | | | | | | $ 2,986,430 |
| o. | TOTAL PRESENT WORTH OF ANNUAL COSTS | | | | | | | | $14,932,160 |

**FOOTNOTES FOR TABLE 11**

1 All values shown are approximate and are included for ROD amendment purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site" dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. Cost estimates are being further refined during the Remedial Design.

2 Annual cost value shown is discounted to first year of "From - To" time period (i.e., 'annual cost' value for Item b. is for Year 2002).

3 P/A Factor represents present value of an annual cost. P/F Factor is present value of a future cost.

4 Present Worth value reflects 1999 funding needed to cover annual cost shown.

5 Table 8-10 of 9/9/97 Tech Memo, Item #3. Costs of Quality Assurance and Work Plans are included in Remedial Design cost shown in previous Table 6. Costs of sampling activity which occurs during Remedial Design are included in Remedial Design costs.

6 Table 8-12 of 9/9/97 Tech Memo, Item called "Annual Monitoring".

7 Table 8-12 of 9/9/97 Tech Memo, Item called "Annual Monitoring for Permanent Operation".

8 Table 8-11 B of 9/9/97 Tech Memo, Item #1.

9 Table 8-11 B of 9/9/97 Tech Memo, Item #2.

10 Table 8-11 B of 9/9/97 Tech Memo, Item #4.

11 Table 8-11 B of 9/9/97 Tech Memo, Item #5.

12 Table 8-11 B of 9/9/97 Tech Memo, Item #3. Site Management costs includes general administration, management, inspection of lagoon area (TIC Remedy), and reporting requirements for the Site.

13 Table 8-12 of 9/9/97 Tech Memo, sum of "New Plant Long Term Maintenance and New Plant Operation". If no GWTP alternative exists or is not available, then contingency may include continued operation of existing GWTP, at a level corresponding to the volumetric fraction of extracted TIC groundwater treated. Annual costs shown reflects technical operation activity, including GWTP repair and preventive maintenance.

14 Table 8-12 of 9/9/97 Tech Memo, Item entitled "Site Management", Years 2007 to 2031. Site Management costs includes general administration, management, and inspection of lagoon area (TIC Remedy) and reporting requirements for the Site.

15 Table 8-12 of 9/9/97 Tech Memo, Item entitled "Site management", Years 2032 to 2101.

## TABLE 12 - APPROXIMATE SCHEDULE FOR FIVE YEAR REVIEW RECOMMENDATIONS; BOFORS-NOBEL SITE

| TASK / MILESTONE | ESTIMATED DATE (no later than) | RESPONSIBLE ORGANIZATION | Affects Protectiveness (Y/N) | |
|---|---|---|---|---|
| | | | Short-Term | Long-Term |
| Approval of RD* for Barrier Wall | 12/30/03 | U.S. EPA / MDEQ | N | Y |
| Start of Construction for Barrier Wall | 4/30/04 | PSDs | N | Y |
| Approval of RD* for Wetland, Protective Soil Cover, & Phytoremediation | 9/30/04 | U.S. EPA / MDEQ | N | Y |
| Start of Short Term Monitoring (to measure barrier wall containment) | 9/30/04 | PSDs | Y | Y |
| Completion of Record of Decision for Operable Unit #2 | 12/30/04 | U.S. EPA (with MDEQ support) | N | Y |
| Start of Construction for Wetland, Protective Cap, & Phytoremediation | 12/30/05 | PSDs | N | Y |
| O.U. #1 TIC Remedy Construction Completion | 12/30/05 | U.S. EPA (with MDEQ support) | Y | Y |
| Five Year Review / Remedy Assessment | 6/30/08 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Start of Long Term Monitoring | 12/30/08 | PSDs | N | Y |
| Five Year Review / Remedy Assessment | 6/30/13 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Five Year Review | 6/30/18 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Five Year Review | 6/30/23 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Five Year Review | 6/30/28 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Five Year Review | 6/30/33 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Five Year Review | 6/30/38 | U.S. EPA (MDEQ, PSDs support) | N | Y |
| Certification of Cleanup Goals ** | 12/30/39 | PSDs; U.S. EPA / MDEQ | N | Y |
| Start of Operation and Maintenance *** | 1/01/40 | PSDs | N | Y |
| Long Term Response Action | Ongoing since 9/94; Completion by 9/60 | PSDs; Sun/Lomac | N | Y |

* RD approval to occur in "phases" to expedite design and construction. Approval of later RD phase includes detailed monitoring programs for the site.

** For the purposes of this Five Year review, a project time period of approximately 35 years from 2003 is used, consistent with the RI/FS time estimate of 43 years (starting from the 1994 groundwater treatment initiation milestone).

*** As defined in the Consent Decree, these are "simple" operation and maintenance tasks such as upkeep of site fencing, general inspections to confirm site and remedy integrity.

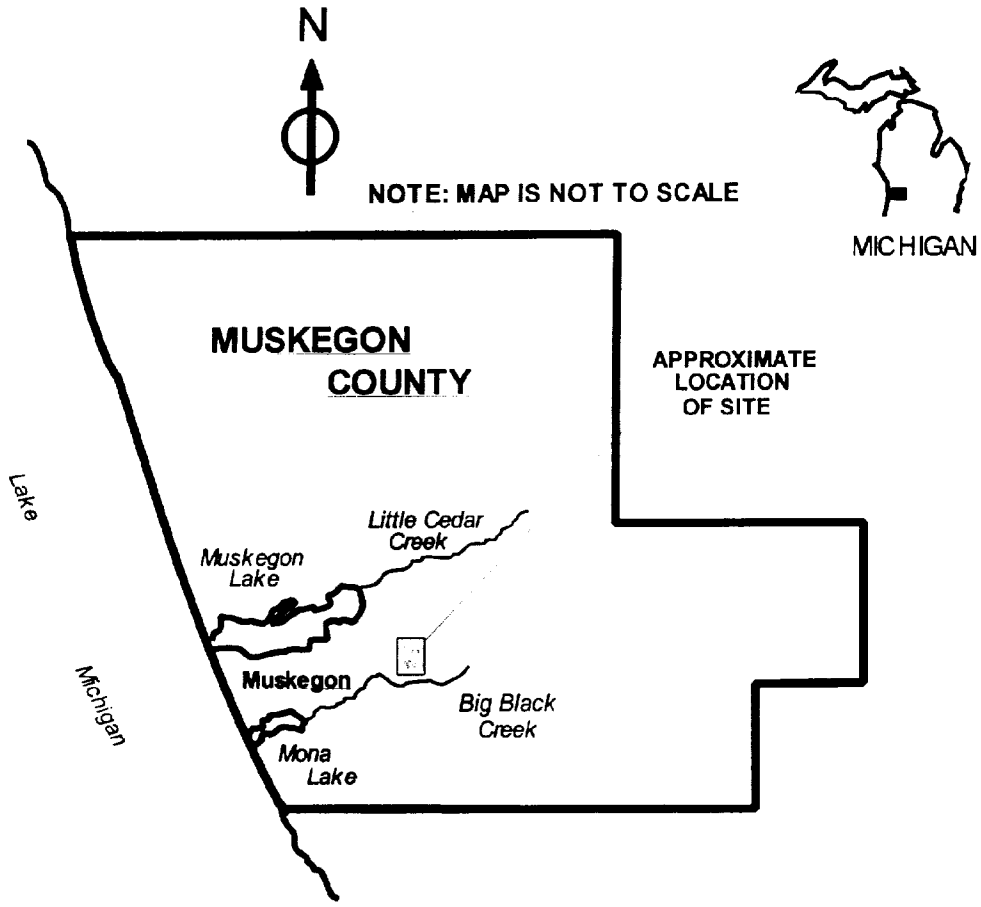



**FIGURE 1 - COUNTY LOCATION OF BOFORS-NOBEL SITE**

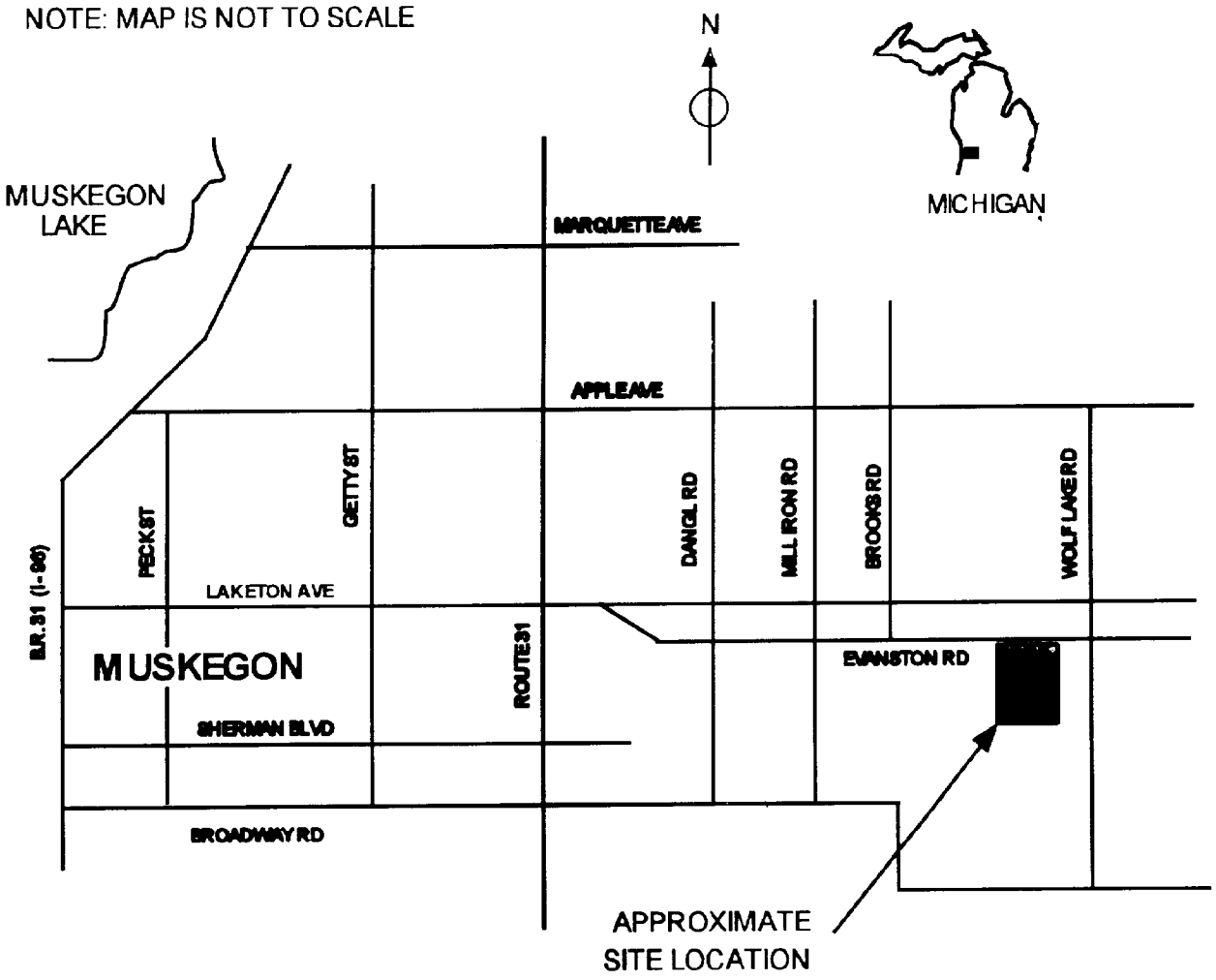



**FIGURE 2 - SITE LOCATION MAP**
BOFORS - NOBEL SUPERFUND SITE;
EGELSTON TOWNSHIP, MICHIGAN

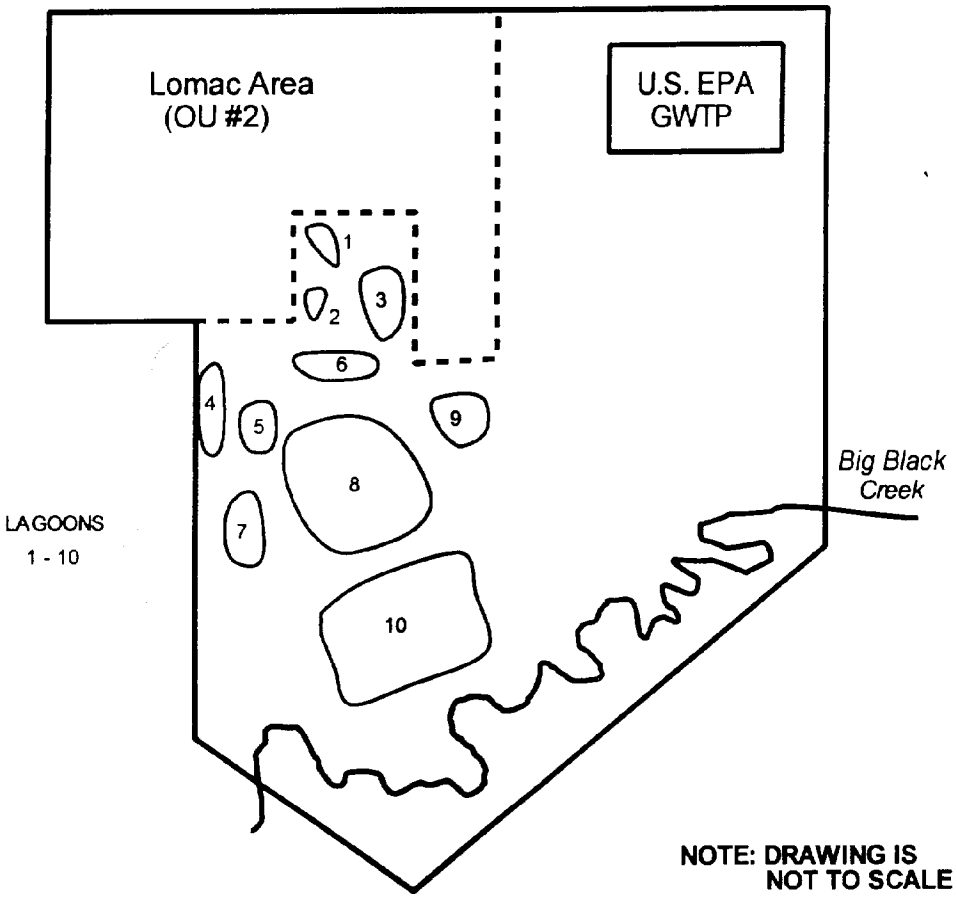
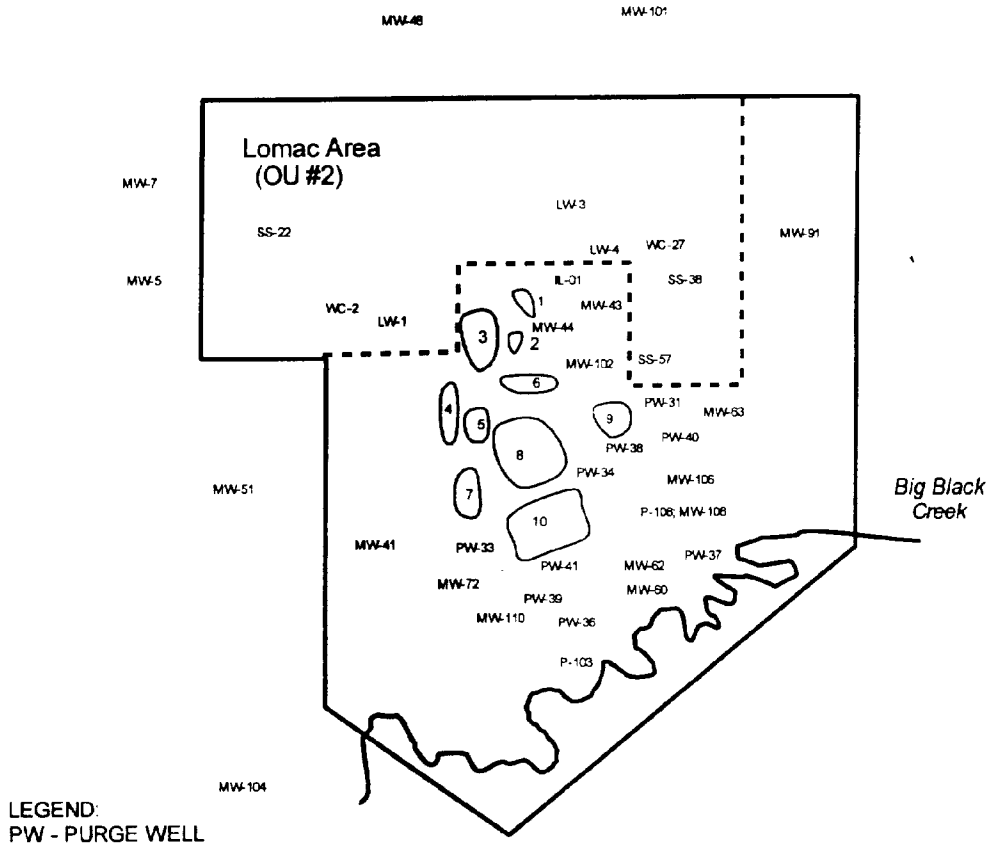



FIGURE 3 - BOFORS-NOBEL SITE LAYOUT




LEGEND:
PW - PURGE WELL
MW - MONITORING WELL
SS - SOIL SAMPLE
P,WC, IL - MONITORING WELLS
LW - LOMAC WELL

NOTE: DRAWING IS NOT TO SCALE

**FIGURE 4 - BOFORS-NOBEL SITE LAYOUT AND APPROXIMATE SAMPLING LOCATIONS**

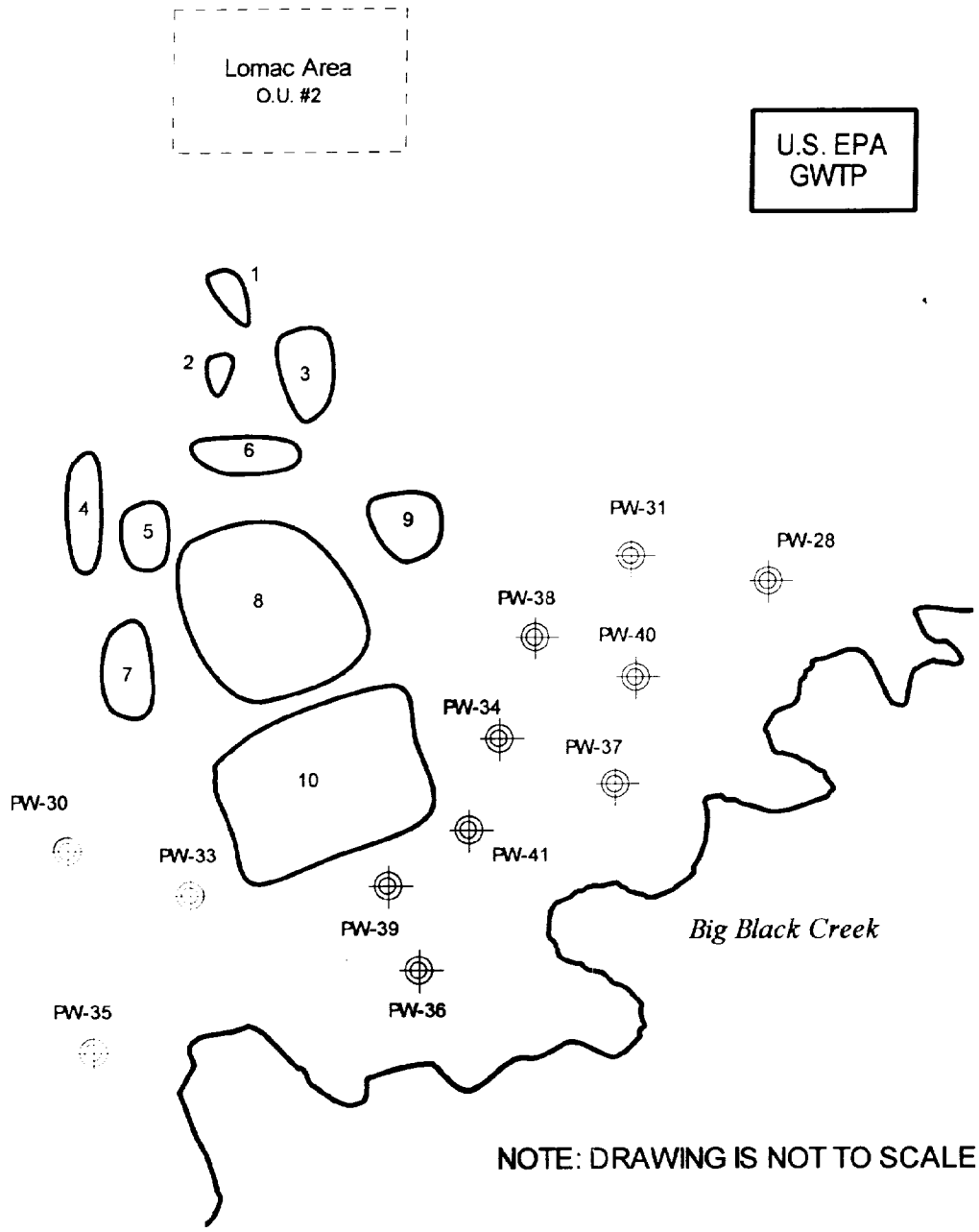



FIGURE 5 - LOCATION OF EXISTING GROUNDWATER EXTRACTION WELLS